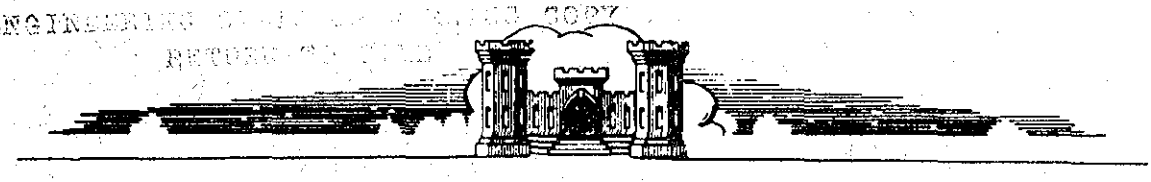
PORTLAND HARBOR

MAINE

SURVEY

(REVIEW OF REPORTS)



U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

SEPTEMBER 15, 1960

SYLLABUS

The Division Engineer finds that Portland Harbor is inadequate for present and prospective commerce. He therefore recommends that the existing project be modified to provide for an entrance channel 1,000 feet wide, 45 feet deep to a line southwest of Fort Gorges and a combination maneuvering basin and anchorage 45 feet deep in the site of the existing 35-foot anchorage, all as shown on the map accompanying this report. The estimated cost to the United States is $8,368,000. for new work, including a cost of $28,000. for aids to navigation, with $2,500. for additional annual channel maintenance and $1,600. additional for annual maintenance of aids to navigation. The improvement which will benefit commercial navigation has a benefit-cost ratio of 6.0.

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U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM 54, MASS.

1961

NEDGW ~~15 Sept. 1960~~

SUBJECT: Survey (Review of Reports) of ~~Portland~~ Monhegan Harbor, Maine

TO: Chief of Engineers, Department of the Army, Washington, D. C.
ATTN: ENGCW-P

See A

AUTHORITY

1. This report is submitted in compliance with the following resolution, adopted 20 August 1957 by the Committee on Public Works of the House of Representatives, United States:

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, UNITED STATES, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on Portland Harbor, State of Maine, published in House Document Numbered 510, 79th Congress, 2nd Session, and subsequent reports with a view to determining if it is advisable to modify the existing project in any way at this time, with particular reference to a 45-foot channel and anchorage."

2. The study was assigned to the New England Division on 21 August 1957.

Purpose and Extent of Study

3. The study was made to determine the economic justification of modifying the existing project to provide for increased commerce in crude petroleum and petroleum products. In preparation of this report a detailed hydrographic survey was necessary. The survey included soundings and probings in the areas desired for improvement. Study was made of available data on the present and prospective use of the harbor by vessels drawing in excess of 30 feet. A public hearing was held at Portland, Maine on December 16, 1958. Information obtained at the hearing is described later under "Improvement Desired." Subsequent to the hearing, local interests were contacted to obtain current data to supplement information previously submitted. Available maps, charts and aerial photographs were studied for the purpose of determining applicability of the plan of improvement.

Description of Navigation Conditions

4. Portland Harbor, located on the southwest end of Casco Bay, Maine, is about 100 miles northeast of Boston Harbor, Massachusetts. It is the largest commercial harbor in the State of Maine. The harbor is formed by a group of outlying islands and a mainland peninsula on which the City of Portland is situated. The combination of islands and peninsula divide the harbor into three sections, the outer harbor, the main harbor and Back Cove.

5. The outer harbor contains 3 large areas currently used for anchorage. One, House Island Anchorage, indicated on the U. S. Coast and Geodetic Survey chart as Anchorage B, is bordered by House Island, Little Diamond Island and Diamond Island Ledge, and contains about 234 acres, 35 feet deep. Another, northwest of Diamond Island Ledge, indicated on the USC and GS chart as Anchorage A, contains about 128 acres deepened to 30 feet. A third anchorage located north of Hussey Sound has about 4 square miles of anchorage with depths varying from 40 to 60 feet.

6. The inner or main harbor is generally southeast of the peninsula. It has a well developed waterfront on which the principal wharves are located. Fore River empties into this section of the harbor about a mile from the tip of the peninsula, and at the Portland Bridge. It contains a 35-foot deep channel extending about 1.5 miles upstream, and may be considered to be an extension of the main harbor. The main ship channel has been deepened to 35 feet, with varying widths, from the entrance to a point just above the former Vaughan Bridge.

7. Back Cove, the area north of the peninsula, is roughly circular having a diameter of about one mile. Most of the area in this section consists of mud flats, exposed at low water. It has a 30-foot channel to its entrance, a 14-foot channel to the former Tukey Bridge, and a 12-foot channel for 2,500 feet upstream. The channels, at the present time, have little commercial significance, their use being confined to a few small pleasure craft.

8. The total waterfront length of the harbor including the City of South Portland, is about 8.5 miles. Serving this waterfront are about 5.8 miles of deep draft channels, including the 2.6 mile entrance channel from the sea at Portland Head to the entrance to the main harbor. The area is shown on U. S. Coast and Geodetic Survey Charts Nos. 315 and 325, on Army Map Service maps of the Portland, East, Portland West, and Cape Elizabeth Quadrangles, and on the maps accompanying this report. The mean range of tide is 8.9 and the spring range 10.2 feet.

Bridges

9. In the portions of the harbor under consideration in this report there is one highway bridge crossing the navigable section of the waterway. This bridge is known locally as the Portland Bridge and is about 1.5 miles above the outer harbor. It is a bascule bridge having a draw span of 97 feet in width with 40 feet clearance above mean high water when closed. Formerly, another highway bridge, Vaughan Bridge, crossed the river about 1.3 miles above the Portland Bridge. This bridge was dismantled in 1958 and a substitute crossing was installed about 1,000 feet above the former bridge and about 700 feet upriver from the end of the 35-foot channel. The new bridge is a combination fixed railway and highway bridge, and is known as the "Veterans Memorial Bridge." It has a horizontal clearance of 101 feet and a vertical clearance of 10 feet above mean high water.

Tributary Area

10. The immediate tributary area consists of the cities of Portland and South Portland, both of which border the harbor. However, since the harbor is the receiving port for the contiguous area, it is considered that the areas comprising all of southern Maine and the adjacent area of New Hampshire are included in the tributary area.

11. The City of Portland is the largest city in Maine. It is chiefly an industrial city, manufacturing many diversified products. South Portland is primarily residential, although the major oil terminals and tank farms serving the locality are situated within its limits. The population of Portland in 1950 was 77,634, with real estate valued at $94,987,125. South Portland in 1950 had a population of 21,866 with real estate valued at $18,262,025.

12. The retail trade area of Portland includes 27 cities and towns which have a combined population of over 250,000. Among these communities, the largest of which are Biddeford, Saco, Sanford, Buxton, Kennebec, Yarmouth, Westbrook, Scarboro, and Springvale, there is a heavy concentration of industry and manufacturing. The principal articles of manufacture are food products, textiles, boots and shoes, machinery and machine parts.

13. Both Portland and South Portland are served by the Boston and Maine Railroad, the Grand Trunk Railway (a subsidiary of the Canadian National Railroad), the Maine Central Railroad, and a connecting line, the Portland Terminal Company. There is also a large modern air terminal, part of which is located in each city. Regularly scheduled flights of freight and passenger service are made from this terminal. There is also

an excellent system of interstate and local highways, which provide excellent bus and truck service to southern and western points.

14. South Portland is the terminus of 2 petroleum pipe-lines which connect to 6 refineries in East Montreal, Canada. About 12,000,000 tons of crude oil are transmitted through these lines annually. In this respect that area of eastern Canada served by these 6 Montreal refineries must be considered tributary to the Port of Portland.

Prior Reports

15. Portland Harbor has been the subject of 21 reports since 1832. Tabulated below are the most recent reports.

Document	Authority	Type of Report	Improvement Considered	Recommendation	Action by Congress
House Document No. 560, 76th Congress 3rd Session	River and Harbor Act August 26 1937	Preliminary Examination and Survey	Anchorage 35 feet deep, approximately 170 acres in area northwest of House Island	Favorable	Authorized March 2, 1945
House Document No. 510, 79th Congress 2nd Session	Resolution by Committee on Public Works House of Representatives	Survey	Deepening the 30' channel to 35' from the Maine State Pier to the Boston & Maine R. R. Bridge, provision of a 35' turning basin at Vaughan Bridge and construction of 900 feet of breakwater from Spring Point to Spring Point Light.	Favorable	Authorized July 24, 1946
Unpublished	Resolution by Committee on Public Works United States Senate	Survey	Anchorage and channel to a depth of 6 feet in Mill Cove	Unfavorable	

Existing Corps of Engineers' Project

16. The existing project for Portland Harbor was adopted July 4, 1836, and supplemented both by enactments from 1866 to 1946, and Harbor line revisions of June 28, 1920. It provides for an anchorage area 35 feet deep, approximately 170 acres in area northwest of House Island; an anchorage area 30 feet deep off the eastern end of the city; a channel 35 feet deep of varying width from the sea to Portland Bridge, thence 400 feet wide in Fore River to the former site of the Vaughan

Bridge thence 300 feet wide to the Boston and Maine Railroad Bridge; a turning basin 35 feet deep easterly of the site of the former Vaughan Bridge; a channel 300 feet wide 30 feet deep from the 30-foot anchorage toward Back Cove to the Grand Trunk Railroad Bridge; a channel 14 feet deep between the Grand Trunk Railroad Bridge and the former Tukey Bridge; a channel 12 feet deep and 300 feet wide from Tukey Bridge 2,500 feet upstream; the removal of two obstructing ledges in the main ship channel to a depth of 40 feet; a stone breakwater about 2,000 feet long on the southerly side of the mouth of the inner harbor; a stone breakwater about 900 feet long from Spring Point to Spring Point Light; and the maintenance of Soldier Ledge channel in Hussey Sound to a depth of 40 feet.

17. Costs under the existing project to 30 June 1958 were $5,439,970 of which $4,284,212 was for new work and $1,155,758 for maintenance. The existing project is complete.

Local Cooperation on Existing and Prior Projects

18. The provisions of the River and Harbor Act of August 8, 1917, as set forth in House Document No. 71, Sixty Fifth Congress required assurance that adequate terminal facilities with berthing depth of 35 feet be provided for deep draft vessels. At a cost of $1,750,000 the State of Maine constructed a pier 1,000 feet long and 328 feet wide with a depth of 35 feet along the easterly side. Construction of this pier is the only measure of local cooperation thus far required for Portland Harbor.

Terminal and Transfer Facilities

19. With the exception of one pier of the Portland Pipe Line Company which is located in the outer harbor, the deep water terminals are located in the main harbor, which includes Fore River to a point just upriver of the former Vaughan Bridge. The general cargo handling facilities are principally on the north or Portland side, and the oil terminal facilities on the south side. Since this report is concerned with deep draft vessel traffic, only those piers concerned with such traffic will be treated in detail in this report.

20. Of the oil terminals the first on entering the harbor is the Portland Pipe Line Company's facility. It has two piers. One is located in the area of the entrance channel and the other just inside the main harbor. The first, of more recent construction, and called Pier No. 2 by the Company, consists of a 975-foot extension to an existing 1,000-foot open pile wharf. The extension includes 4 mooring dolphins with connecting pipe trestles and a breasting platform 290 feet long. Mooring dolphins and trestles have concrete decks on open steel pipe piles filled with concrete. The breasting platform is of similar construction. This pier has a berth dredged to a depth of

42 feet. The second pier of this terminal, being the older pier and called Pier No. 1 by the Company, is 882 feet long. Its construction consists of 4 steel sheet pile shells, with solid fill, connected by a 10-foot wide pipe trestle and catwalk, and an open pile concrete decked platform 30 by 90 feet long. Two berths 35 feet deep are located on either side of this wharf. This facility has about a 2,200,000-barrel storage capacity. It has 1 12-inch and 1 18-inch pipeline extending from the plant to East Montreal, Canada. There are no railway connections to either of these piers.

21. Adjacent to Pier No. 1, inside the main harbor, and upstream of it is located the Pocahontas - Calso Oil Terminal. This wharf is an open pile wharf 600 feet long. It has a 600-foot approach, a 280-foot berth length, and a 32-foot depth in the approach and berth. It also has railway and highway connections. The terminal has a storage capacity of 690,000 barrels.

22. Proceeding upriver the next oil terminal is the Texas Oil Company. Its wharf is in South Portland 1,900 feet above the Portland Bridge. It is an L-shaped wharf of pile and timber construction, a usable berthing space of 280 feet at a depth of 28 feet and a storage capacity of 275,000 barrels.

23. The next oil wharf upstream is the Mexican Petroleum Corporation and American Oil Company wharf. Its construction consists of a timber pile, concrete-decked platform with a 300-foot pipeline trestle and walkway from shore. It has a depth of 30 feet in its berth. Storage capacity of the terminal is 422,500 barrels.

24. The Socony-Mobil Oil Company has 2 wharves 1 60 feet upstream of the former Vaughan Bridge, the other 350 feet downstream. The upper wharf is not presently used. Both wharves are of timber and pile construction. The lower wharf has a 505-foot berthing space 25 feet deep. Storage capacity of this terminal is 340,000 barrels.

25. The next pier upstream is operated by the Cities Service Oil Company. Its construction consists of wood-pile and timber pier with wood-pile mooring dolphins. Berthing depths at the pier are 20 feet. Two companies receive petroleum products at this terminal. The Cities Service Company has a storage capacity of 175,000 barrels and the Jenney Manufacturing Company has a capacity of 7,950 barrels.

26. The next pier upstream on the South Portland side is known as the Rolling Mill T-Wharf. It is of wood-pile and timber construction. It has a usable berthing space of 80 feet with a depth of 20 feet. Three oil companies are served by the wharf. Tidewater Associated Oil Company has a capacity of 203,600 barrels, and Richfield Oil Company has a capacity of 226,600 barrels. Shell Oil Company uses this wharf in conjunction with an alternate wharf immediately upstream.

27. The last pier on the same side is known as the Rolling Mill L-Wharf. It is of wood-pile and timber construction, with 375 feet of berthing space at a depth of 30 feet. Three oil companies occupy this facility, Shell Oil, Esso Standard, and Gulf Oil. Their storage capacities are 437,500, 426,000 and 392,000, respectively. At the present a larger pier is being designed for these facilities. Storage capacities of the terminals will be increased as circumstances warrant.

28. On the left bank of the river opposite the Cities Service wharf, the Gulf Oil Company has a wood-pile and timber wharf. It has a berthing space of 200 feet with a depth of 30 feet. This facility has a storage capacity of 334,000 barrels.

29. In summation, there are 13 oil companies with a total storage capacity of 5,479,850 barrels of oil. Eleven wharves serve these facilities. In addition there is one wharf serving the Central Maine Power Company. Storage capacity at this wharf is 60,000 barrels.

30. In addition to the oil wharves there are 9 general and bulk cargo wharves serving deep draft shipping. Of the 9 wharves, one is State-owned and the remainder privately owned. There are also 2 wharves operated by the United States Coast Guard. These wharves are used primarily for boats engaged in servicing aids to navigation.

31. The first of these terminal facilities on entering the harbor lies on the Portland side. It is owned by the Grand Trunk Railroad. Commerce at the facility consists of grain and general cargo. Three wharves are located at this terminal. Of the three, one is not in current use, and another is partly dismantled, being used on only one side. The remaining wharf, Grand Trunk No. 3, is of wood pile and timber construction. It has berth spaces on either side 525 feet long and 35 feet deep. In connection with this wharf there is a grain elevator with a storage capacity of 1,500,000 bushels. The wharf in part use, Grand Trunk No. 2, is of the same type of construction and has a berthing space of 500 feet, 30 feet deep.

32. Immediately upstream of the Grand Trunk facility is the Maine State Pier. This pier is of wood pile and timber construction. It has a berthing space of 1,000 feet, 35 feet deep. A two-story transit shed with a storage space of over 200,000 square feet is located on this pier. Commerce consists of general cargo both foreign and domestic.

33. The next wharf upstream is the A. R. Wright Company wharf. It is about 1,500 feet below the Portland Bridge. This wharf is constructed of a steel sheet pile and masonry retaining wall with solid fill and a timber pile and deck extension on its face. It has a berthing space of 685 feet, with a depth of 28 feet for most of its length. This wharf is used as a coal terminal, having a storage area with a capacity of 50,000 tons.

34. The Portland Terminal Company operates a marginal wharf immediately below the Portland Bridge. Its construction consists of a masonry bulkhead with solid fill and a pile and timber extension. Berthing space along its face is 950 feet at a depth of 30 feet. It has an 800- by 125-foot transit shed with 100,000 square feet of storage space. General cargo is handled at this pier. This company has another wharf about 1,000 feet above the Portland Bridge. This wharf is marginal and of wood pile and timber construction. It has a berthing space of 1,400 feet along its face with a depth of 30 feet. The wharf handles bulk cargo.

35. In addition to the wharves described above there are 32 other wharves in the harbor. Depths of these wharves vary from 6 to 25 feet. Principal uses of these wharves include receipts of fish, mooring old vessels, towboat wharves, and boat building and marine contractors' wharves.

Improvement Desired

36. In order to determine the nature and extent of navigational improvement desired by local interests, a public hearing was held at Portland, Maine on December 16, 1958. The hearing was well attended. Included in the attendance were a Congressman and Congressman-elect, representatives of the State of Maine, officials of the City of Portland, representatives of shipping and terminal interests, local harbor pilots, and other interested citizens.

37. The Maine Port Authority presented an overall plan of improvement which was cited as being representative of the chief desire of local interests for navigational improvement. In the plan various phases of improvement were assigned priorities, with the most urgently needed given top priority. The improvements requested are listed below in order of priority.

(a) Deepen 3 shoal areas, believed to be rock ledges, in or near mid-channel, which are now 35 to 38 feet below mean low water, to a depth of 45 feet,

(b) Deepen the existing 35-foot House Island anchorage to a depth of 45 feet,

(c) Dredge an alternate 45-foot deep entrance channel between Hussey Sound and the House Island anchorage,

(d) Deepen and enlarge the existing 30-foot anchorage northwest of Diamond Island ledge to 35 feet,

(e) Deepen 2 shoal areas near the limits of the entrance channel to 45 feet.

38. The Maine Port Authority declared that numerous difficulties are now experienced in navigation of the waterway. The difficulties were classed as tidal delays, obstructions, tidal currents and maneuverability. All are caused primarily by shoal conditions in the entrance channel. As an example, the case of ships drawing 35 or more feet was shown. Should these ships approach the harbor two hours prior to low tide, entrance is not possible and a wait of at least 4 hours is necessary. Swell conditions, if present, lengthen this delay. Maneuverability of the ships is also affected. As the ships transit the channel, of necessity progress must be at slow speed, due to the restriction imposed by the width of the channel. The ship's course leads directly over the shoals, which lie close to mid-channel. As the bow approaches the shoal, a cushion effect is set up which tends to throw the ship off course. This effect is increased further when the stern passes over the shoal. Correction of the ship's course can only be obtained by increasing the ship's speed for a period of time to provide for extra rudder action and a return to course. The increase in speed itself is considered hazardous in a restricted channel, particularly with large tankers of the 40,000 to 47,000 deadweight ton class with lengths up to 750 feet. Because of these conditions and in the interests of safety, the Portland Pilots Association has declared that it will not allow its pilots to take ships over 750 feet long and 38 feet draft into the harbor. The Association further declared that the bigger ships would only be taken in under the most favorable weather conditions. The Authority declared that deepening the channel would remove the restrictions on the existing shipping and allow navigation for larger ships of the 60,000 to 65,000 deadweight ton class, which have drafts of 42 to 44 feet.

39. At the present time anchorage in the vicinity of the developed portion of the harbor is concentrated in two areas, the existing 35-foot anchorage north of House Island and the 30-foot anchorage between Diamond Island Ledge and Fish Point, Pomroy Rock. Boats drawing more than 30 feet are unable to use these anchorages. Consequently these boats are forced to seek anchorage in Hussey Sound about 6 miles distant. Local interests claim that in the event of bad weather, or a breakdown of a vessel, there is no close anchorage and ships are forced to remain at the terminal or be towed to Hussey Sound, thus entailing considerable expense. It was stated that considerable benefit would ensue from provision of deep anchorage near the developed portion of the harbor.

40. Coincident with deepening the House Island anchorage to 45 feet, deepening of a 30-foot anchorage was requested. It was claimed that the 45-foot anchorage would be about sufficient for the larger vessels and the smaller vessels would have to be accommodated elsewhere, preferably near the developed section of the

harbor. This claim was made in anticipation of the general increase in size of vessels to be used when the entrance channel is deepened.

41. The alternate 45-foot deep entrance channel through Hussey Sound was requested for strategic reasons. It was stated that the harbor would have, with deepening of the present entrance channel, only one entrance for deep draft vessels in excess of 35 feet. Should any major catastrophe occur in this entrance the port would be closed for a considerable period of time, due to the limited channel width. This could cost considerable loss of money as well as being a detriment to the proper operation of the port during times of emergency.

42. The removal of two shoals near the channel edge listed under Priority "E" was requested to provide for further widening of the channel thus reducing the chances of groundings, with resultant damage to vessels.

43. The American Merchant Marine Institute Inc., a trade association of 51 United States steamship companies, submitted a statement advocating navigational improvement of Portland Harbor. Three of its member companies are currently using the harbor. These companies, California Shipping Company, Esso Standard Oil Company, and the Texas Company, provided the information on which the Institute's statement for improvement was based. In support of improvement the Institute indicated that commerce in petroleum and petroleum products has increased steadily in recent years, reaching a volume of 15,476,000 tons in 1957. To carry this volume and the anticipated increased volume of such commerce more economically the use of larger size tankers will be required. Two of the member companies have indicated more frequent use of 47,000 dwt tankers, which are the maximum size that the Portland pilots will take into the harbor. The two companies have also indicated future use of 65,000 and 73,000 dwt tankers, if harbor improvements should be made.

44. The Institute concurred with the Maine Port Authority's plan for correction of the navigational difficulties prevailing in the harbor, except for the proposal for a second channel to Hussey Sound. The navigation difficulties were stated to consist of tidal delays ranging from 2 to 6 hours for deep draft vessels, and insufficient depth for the navigation of tankers larger than 47,000 dwt and 38-foot draft. The inadequacy of the present 35-foot anchorage was mentioned. It was stated that this anchorage is safe only for vessels drawing 30 feet or less, when consideration is made of uneven trim and the effects of swell. Consequently 28,000 deadweight ton or larger vessels anchor in Hussey Sound, when necessary. This practice is considered uneconomical as additional towage, pilotage, and sailing time are involved prior to the vessel's docking.

45. The Institute computed benefits to be derived from improvement. In 1957 two of its member companies transported 6,290,000 tons of petroleum from the Middle East and South America to Portland Harbor. The companies estimated that if 47,000 dwt tankers had been used in lieu of 28,000 dwt a savings in transportation cost of $0.88 per ton for Middle East petroleum and $0.40 per ton for South American petroleum could have been effected. This would amount to about $4,000,000 in annual savings for the 1957 commerce. Additional benefits could be obtained by delivery to Portland in 65,000 dwt tankers and pipe line to Montreal in lieu of 28,000 deadweight ton tanker delivery to Montreal via the St. Lawrence River. This would represent an estimated savings of about $0.80 per ton.

46. Savings in reduction of tidal delays were also estimated. The savings were based on a predicted 1965 commerce of 13,800,000 tons of crude petroleum. It was assumed that one-half of this commerce would be carried in 47,000 dwt tankers. Without improvement these tankers average 3 hours delay per trip. It would require 147 trips of these tankers to carry one-half the commerce, or 6,900,000 tons. Thus the total delay would be 441 hours. The hourly value of these tankers at sea is estimated at $320. Elimination of the tidal delays would thus result in an annual savings of 441 x $320 or $141,000.

47. It was also estimated that 25 percent of the 1965 commerce would be carried in 28,000 to 40,000 dwt tankers. By using an average load of 30,000 tons for the vessels expected to carry the petroleum it was estimated that 142 vessel trips would be required. The average tidal delay for these vessels was estimated at 1 hour and the value $260 per hour. Thus an annual savings of 142 x 260, or $37,000 would be realized from elimination of tidal delays for these boats.

48. Savings in transportation costs made possible by the use of 65,000 dwt tankers in the deepened harbor were also evaluated. It was estimated that 5 percent of the 1965 commerce would be carried in this type of vessel. Total annual savings were estimated $135,000.

49. Total estimated annual benefits from the sources described above amount to $313,000.

50. The Portland Pipe Line Corporation also submitted a statement in support of improvement. This company is a United States company incorporated under the laws of the State of Maine. It operates a main tank farm at South Portland and 12-inch and 18-inch pipelines, each 166 miles long, extending from South Portland to the International Boundary at North Troy, Vermont. The pipelines connect with the lines of the Montreal Pipeline Company Limited which in turn connect to a delivery terminal at Montreal East. The terminal serves six refineries in the Montreal area. These refineries jointly own the Montreal Pipeline Company Limited, which in turn owns all the shares of the Portland

Pipeline Corporation. The refineries are Imperial Oil Limited, British American Oil Company Limited, McColl-Frontenac Oil Company Limited, Shell Oil Company of Canada Limited, British Petroleum Company, and Canadian Petrofina Limited. During the 5 months of the winter when the St. Lawrence River is ice-bound, the refineries receive all of their crude via the pipe lines. In the remaining 7 months 85 percent of the crude is received via pipe line.

51. The company cited its position as a new industry in 1941 and its steady increase in operations since that time particularly in the period after World War II. It emphasized the fact that all of its revenues are derived from outside the area which it serves, the revenues accruing from the charges paid by the 6 Montreal refineries for piping the oil. These revenues benefit the area in terms of wages, local taxes and expenditures for power and other incidental expenditures. The total of such expenditures in 1957 was estimated at $4,015,000. The benefits from these expenditures were accrued in three states through which the lines run, Maine, New Hampshire, and Vermont. In addition, the Portland Pipe Line Company paid $1,454,000 in Federal income taxes for 1957. Other local benefits accruing to the Portland area were also cited. These were estimated to amount to between $2,000,000 and $3,000,000 and result from normal expenditures of the ships visiting the harbor, such as pilotage, service and supplies, and repairs.

52. Originally, the company had constructed one 12-inch pipeline, and used one pier, its present Pier No. 1. In 1945, a tanker, which had unloaded at this pier, could not sail due to adverse weather conditions and remained at the pier. The storm caused the moored tanker to pitch and roll, buffeting the pier to such an extent that it had to be reconstructed. During the ensuing year the company replaced the pier with an 882-foot pier, with room for one 32,000 dwt tanker on either side. Oil receipts increased steadily and it was found necessary to build another pipeline to accommodate the increased traffic. This line, 18 inches in diameter, was completed in 1950. After this line was installed it was found necessary to build a second pier. This pier was designed to accommodate 65,000 deadweight ton tankers and was completed in 1956. To date it has not been able to take the ships for which it was designed as the navigational difficulties inherent in the existing channel preclude the passage of ships of such size.

53. The company quoted information received from some of its shipping companies relative to proposed future shipping into Portland Harbor. One of these shipping companies stated that one of its affiliates was currently completing a program of construction of 35,500 to 37,800 dwt vessels. It anticipated that these vessels would replace its T-2 and 18,000 dwt tankers, either laying them up or selling them. Another of the same Company's affiliates is constructing

47,400 dwt tankers which will be used in the Portland trade, if the harbor can accommodate them. In addition, the same affiliate is building crude carriers of 73,000 dwt. It was stated that these carriers will be used in the Portland trade, should harbor improvements be made in accordance with the Maine Port Authority's request. A third company stated that it had four chartered ships of 65,000 dwt which could be used in the Portland trade if harbor facilities were suitable. These vessels are 835 feet long, have a beam of 108 feet and a loaded draft of 45 feet.

54. Savings that could be made by the use of larger ships were shown. The Portland Pipeline Corporation estimated that it could have saved $5,000,000 in transportation costs alone, in 1958, if all of its oil receipts could have been carried in 45,000 dwt tankers or larger, in lieu of the 28,000 to 30,000 dwt movement in that year. It also estimated that if only 15 percent of its 1958 movement in oil could have been moved in 60,000 dwt vessels, a savings in transportation costs of $700,000 could have been made.

55. Subsequent to the hearing requests were made for a study to determine the justification of providing either a 37- or 38-foot channel in Fore River. Estimates of the costs of either of these channels indicated the costs to be $1,230,000 for the 37-foot channel and $2,750,000 for the 38-foot channel. Neither of these channels could be justified on the basis of anticipated commerce over the 50-year project life.

Existing and Prospective Commerce

56. Existing Commerce. - Portland Harbor is a receiving port, its chief commodity crude oil. In 1958 the total commerce was 15,590,854 tons, of which 75 percent or 11,647,404 tons were crude oil. In addition, 3,164,336 tons of petroleum products were included in the total commerce. The combination of these two commodities accounted for 95 percent of the total commerce. The remaining commerce included 492,218 tons of bituminous coal, with lesser amounts of fish, wheat flour, clays and earth, sulphur, and various other products.

57. In the most recent decade, for which statistics are available, the total tonnage has increased by about 127 percent. The increase is attributable chiefly to receipts of crude oil, which rose from 3,267,961 tons in 1949 to 11,647,404 tons in 1958. Unofficial statistics for 1959 indicate 12,880,000 tons of crude oil were received. The 1949 tonnage represented about 48 percent of the total commerce, the 1958 tonnage 75 percent. The crude oil is received at one terminal then transhipped by pipelines to Montreal. The pipelines serve as a common carrier for 6 refineries in Montreal.

58. In addition to the crude oil, commerce in petroleum products has also increased substantially. The 1949 total of such products was 2,266,552 tons and the 1958 total 3,164,336, representing a 40 percent increase in a 10-year period. These products are received at 9 terminals on Fore River and transhipped via truck, train, and barge to points in the tributary area.

59. Prospective Commerce. - The commerce in Portland, from all apparent indications, will continue to increase. It is not anticipated that the rate of growth in crude oil commerce, noted for the past 10-year period, will prevail over the anticipated life of the project. The rapid rise in the past is attributable to two factors, more economical transportation costs, by the use of larger vessels, and the servicing of 2 more refineries, established within that period. It is estimated that the commerce will show a decided rise in the first few years of improvement and then follow more closely the increases in demand for the area it serves. This estimate considers a diversion of the St. Lawrence traffic to the Portland route. Such increases in demand are conservatively estimated to be 2 percent per year over the 1958 tonnage. The Portland Pipeline Inc. has stated that it has enlarged its facilities as the need arose. It further stated that it at present has a plan of expansion, to provide for future increases in commerce over the life of the project. Projected capital outlay in this respect would total about $750,000 in fiscal year 1961.

60. Commerce in petroleum products is also expected to increase at about the same rate as the crude. This estimate is considered conservative also, with respect to the past 10-year period which showed an overall increase of 40 percent for the period. However, it appears to be reasonable over the anticipated life of the project. Prospective commerce is discussed in more detail in Appendix A.

61. Vessel Trips. - In 1958 there were 12,211 vessel trips inbound to the harbor. Of this total 222 had drafts of 34 or more feet. These vessels are subject to tidal delays in the entrance channel varying with their draft and with the amount of ocean swell present. In addition there were 241 trips of vessels with drafts varying between 31 and 33 feet. These vessels are subject to tidal delays in the 35-foot Fore River Channel, and in times of heavy swells, delays in the entrance channel. All of the vessels involved in these trips were tankers the largest of which docked at the Portland Pipeline Corporation wharf adjacent to the entrance channel, and the remainder at terminals on Fore River, including a second wharf of the Portland Pipeline Corporation on the river.

62. Over the most recent 10-year period the frequency of deep draft vessel trips has increased considerably. In 1949, 88 trips of vessels drawing more than 30 feet were made. In 1958, 463 such trips were made. The deepest draft vessel navigating the waterway in 1949,

had a draft of 33 feet. In 1958 the deepest draft vessel had a draft of 38 feet. Local interests have stated that should improvement be effected, more deep draft vessel trips will be made and that vessels with drafts to 45 feet would be used.

63. Tabulated below is a detailed statement of vessel trips for 1958.

Trips and Drafts of Vessels - 1958

Inbound

	Self-propelled Vessels			Non-self-Propelled Vessels		
Draft(ft)	Passenger and Dry Cargo	Tanker	Towboat or Tugboat	Dry Cargo	Tanker	Total
38		1				1
37		11				11
36		38				38
35		86				86
34		86				86
33		50				50
32		78				78
31		113				113
30	22	81				103
29	26	18				44
28	1	6				7
27	2	1				3
26	2	1				3
25	10	3				13
24	9	4				13
23	12	2				14
22	18	2				20
21	18	1		1		20
20	12			2		14
19	14	2				16
18 & less	10,673	777	20	3	5	11,478
Total	10,819	1,361	20	6	5	12,211
Total net register tonnage	1,002,429	5,815,540	2,923	11,249	5,995	6,838,136 (1)
Passengers						175,669

Trips and Drafts of Vessels - 1958 (Cont.)

Outbound

Draft(ft)	Self-propelled Vessels: Passenger and Dry Cargo	Self-propelled Vessels: Tanker	Self-propelled Vessels: Towboat or Tugboat	Non-self Propelled Vessels: Dry Cargo	Non-self Propelled Vessels: Tanker	Total
38						
37						
36						
35						
34						
33						
32						
31						
30	1					1
29		1				1
28	1	3				4
27	2	4				6
26	3	10				13
25	6	41				47
24	12	60				72
23	13	119				132
22	19	77				96
21	10	58		1		69
20	16	112				128
19	34	40		1		75
18 & less	10,700	826	22	4	5	11,557
Total	10,817	1,351	22	6	5	12,201
Total net register tonnage	1,045,338	5,790,074	3,173	11,249	5,995	(1) 6,855,829
Passengers						199,746

Local

Draft(feet)	Self-propelled Vessels: Passenger and Dry Cargo	Self-propelled Vessels: Tanker	Self-propelled Vessels: Towboat or Tugboat	Total
18 and less	49	461	4	514
Total net register tonnage	764	11,222	20	12,006

(1) Excludes total net register tonnage for 200 vessels engaged in foreign trade.

Difficulties Attending Navigation

64. Tankers have increased in size to a considerable degree in recent years. This fact is particularly true for those vessels engaged in foreign trade. With the increase in size, vessel-drafts have increased correspondingly making previously adequate harbors increasingly difficult to navigate. This condition exists in Portland Harbor at the present time. The authorized channels and anchorages were designed for vessels drawing 30 feet. The major portion of the foreign commerce in crude oil is carried in vessels drawing from 2 to 8 feet more than the 30-foot design depth. Consequently navigation of the authorized 35-foot harbor channels is possible only during stages of tide varying from 2 to 8 feet, dependent on the draft of the vessel. This condition results in delays for the vessels and higher transportation costs for the cargoes.

65. The tidal delays described above are further compounded by the condition of the entrance channel. The controlling depth of this channel is about 38 feet. The shoals consist of rock ledges and a hard gravel bar. The entrance channel is partly exposed and subject to ocean swells ranging from 2 to 4 feet for about 20 percent of the time. The combination of swells and inadequate depths also contributes to delay time incurred by vessels. This delay time could be as much as 24 hours, according to local interests inasmuch as vessels not able to transit the entrance channel are forced to proceed to Hussey Sound, about 5 miles north and await abatement of the swell.

66. The authorized House Island anchorage is 35 feet deep. Local interests point out that the larger ships drawing over 32 feet cannot utilize this anchorage, and that often some of the swell enters this anchorage, making it hazardous for vessels drawing 33 or more feet. The larger ships now dock at high water slack, as in the past damage to vessels has occurred due to the combination of swell and tidal currents. With improvement vessels will dock at either high or low water slack. Deepening the 35-foot anchorage will provide space for the vessels to await slack water.

Water Power and Other Special Subjects

67. There are no matters, involving water power, flood control, pollution, and related subjects, concerned with this study. The requested improvement would have no adverse effect on wild life or shellfish.

Plan of Improvement

68. The overall plan of improvement, as requested by local interests, consists of 5 particular items which were to be accomplished in a definite order of priority, as described in the section of this report under, "Improvement Desired." First, in the order of priority, was the deepening of 3 high spots in the entrance channel, as shown on the map accompanying this report. Hydrographic surveys of the 3 high spots and the contiguous areas

showed that one spot consisted of ledge rock at a top elevation of 38 feet, and the remaining 2 were connected by a subaqueous bar of ordinary materials with depths ranging from 38 to 43 feet. There is also another ledge rock area previously removed to a depth of 40 feet in the channel near the southwest corner of the House Island Anchorage. Deepening of these areas would provide for a channel 1,000 feet wide and 45 feet deep. The second improvement entailed deepening of the existing 35-foot anchorage in the vicinity of Hussey Sound. It was found that this part of the requested improvement was feasible and therefore included in the plan of improvement. The third, deepening and enlarging the existing 30-foot anchorage was found to cost from $5,000,000 to $18,000,000, depending on the size, and to be incapable of economic justification. The fourth phase of requested improvement would consist of provision of a channel from House Island Anchorage to Hussey Sound. The channel would be 45 feet deep and be used as an alternate entrance channel in case of emergency due to the blocking of the main entrance channel. It was found that provision of a channel 600 feet wide and 45 feet deep would entail dredging of approximately 6,300,000 cubic yards at an estimated cost of about $11,000,000. It was considered that insufficient benefits for the relatively high costs of providing an alternate channel could be derived. Therefore no further consideration was given to this phase of the requested improvement. The final and fifth part of the requested plan would consist of removing two shoals on either side of the 1,000-foot channel described above. These shoals were not considered to be serious impediments to navigation, particularly with provision of a 1,000-foot channel, obtainable by removal of the other 3 shoals. Therefore, no further consideration was given to this phase of the improvement.

69. During the course of the study of Portland Harbor, consideration was given to every aspect of improvement requested by local interests. Feasibility, need, and economical justification were studied. From these studies it was determined that two items of the requested overall improvement were justifiable for the needs of present and prospective commerce in the harbor. The two items, found justifiable, were provision of an adequate entrance channel and an adequate sheltered anchorage inside the harbor. Generally, the plan of improvement thus found feasible consists of an entrance channel 1,000 feet wide and 45 feet deep with a combination anchorage and turning basin 234 acres in area, and 45 feet deep. This plan of improvement is considered adequate to serve the needs of present and prospective traffic.

70. In subsequent discussions with local interests requests were made for deepening the existing 35-foot channel in Fore River to 37 or 38 feet. It was stated by them that such depths would eliminate tidal delays now experienced by some of the vessels using the waterway. It was also stated that tankers with deeper draft than the present tankers in use on the waterway will carry the prospective commerce. However,

the benefits to be derived from the deeper draft ships were on analysis found to be limited to reduction in tidal delays, and were computed and found to be insufficient to economically justify deepening the existing 35-foot depth. Benefit-cost ratios for the 37- and 38-foot channels were computed and found to be 0.6 and 0.5 respectively.

71. In the design of the depth of the entrance channel several factors had to be taken into consideration. These factors included swell conditions, the squat of vessels underway, uneven loading, adequate hull clearance, and the character of the bottom materials. Swell prevails in the harbor entrance channel at various times during the year. It is particularly noticeable after strong offshore southeast or easterly storms. Wave studies of swells indicated that the waves could proceed into the harbor, but no accurate determination of maximum height or prevalence of them could be made due to the presence of several offshore shoals. However, it is conservatively estimated from statements of vessel masters and local pilots that a 2- to 3-foot swell exists after strong easterly storms. This factor was considered in the design of the entrance channel.

72. Ships underway are subject to a condition known as squat. This condition results from a lifting of the bow with a corresponding sinking of the stern caused by propellor thrust. Maximum dislocation for this condition in the entrance channel is about a foot, added to the draft of the vessel. There is also the problem of uneven loading usually attributable to inbound ships having consumed a large part of its fuel in a long overseas voyage. A 1-foot allowance was made for this contingency. Hull clearance of 3 feet is considered necessary in this location. The clearance allows for rudder workability for efficient propellor action, and avoidance of bearing damage by the suction of bottom materials, caused by propellor action. The sum of the latter 3 factors allows for 5 feet more than the loaded summer draft. Tidal delays were computed using this allowance. The 5-foot clearance, while seemingly large, will give a safety factor in times of swell. Also, the bottom materials, being rock in some cases, makes a high safety factor very desirable for this location.

73. In consideration of these factors, it was felt that the 45-foot depth requested by local interests was reasonable. This depth will not, at all times, provide for access to the harbor for the prospective larger tankers, with drafts in excess of 40 feet. These tankers will be subject to tidal delays, which, however, would not amount to enough to justify the cost of further channel deepening.

74. The 1,000-foot channel width was selected as the most economical consistant with the interests of safe navigation. The 1,000-foot width will allow for some sheer action to which the

vessels are subject in this location while lining up to proceed with the direction of the tidal current.

75. The plan of improvement includes deepening the existing 35-foot anchorage to 45 feet. The area will serve a dual function, both as turning and maneuvering basin and as sheltered anchorage. The maneuvering area will be located adjacent to the channel and will allow for the turning and maneuvering of vessels prior to docking or turning to proceed outbound after discharging cargo. As the largest tanker expected to use the harbor is about 850 feet long, and safe navigation requires that 1 to 1½ ship's length should be allowed for turning, it was considered that part of the existing anchorage should be improved for turning and maneuvering. The remainder would provide for sheltered anchorage. A depth of 45 feet was considered necessary as the largest tankers will have drafts of 42 feet, thus giving allowances for minus tides, swell or uneven loading.

Shoreline Changes

76. The proposed improvement would have no effect on the configuration of the shore in the vicinity of the desired improvement.

Required Aids to Navigation

77. The U. S. Coast Guard has been consulted and has indicated that one additional aid to navigation will be required for the proposed improvement. Also, several existing aids will require relocation. Estimates of costs submitted are $28,000 for initial installation, with $1,600 for annual maintenance.

Estimates of First Cost

78. Estimates of first cost of the proposed plan of improvement have been made. Estimates of first costs of the remaining phases of the improvements desired have been made and are detailed in Appendix C of this report. Probing surveys indicate that dredging quantities would be of ordinary materials in the anchorage and ordinary materials plus rock in the entrance channel. Dredging quantities are in terms of in-place measurement with a 2-foot overdepth allowance and 1 on 3 side slopes. Due to the nature of bottom materials, which in the main are hard, it is considered that the dredging will be accomplished by bucket dredge and disposed at sea. Dredging costs are based on experience and reflect prices current in September 1960.

Project Construction

Corps of Engineers

Dredging Entrance Channel and Maneuvering Area (75 acres), 1,000 feet wide, 45 feet deep	$3,570,000*	
Engineering and Design	20,000	
Supervision and Administration	200,000	
Total		$3,790,000
Dredging Existing 35-foot Anchorage, 156 acres in area to 45 feet	4,320,000	
Engineering and Design	30,000	
Supervision and Administration	200,000	
Total		4,550,000
Preauthorization Studies		35,000
Project Construction Cost		$8,375,000

U. S. Coast Guard

Additional Aids to Navigation	28,000
Total Project Cost	$8,403,000

* Includes Contingencies

Estimates of Annual Charges

79. The estimated annual charges are based on a project life of 50 years, at an interest rate of 2.625 percent. The estimated shoaling rate for the channel is based on the character of the bottom materials, the tidal current, and on experience gained in the 35-foot Fore River Channel. Based on these factors, it is estimated that the shoaling rate will be about 1,000 cubic yards annually. Federal annual charges are detailed below.

Federal Investment

Corps of Engineers	$8,375,000
U. S. Coast Guard	28,000
Total Federal Investment	$8,403,000
Federal Annual Charges	
Interest (8,403,000 x .02625)	220,600
Amortization (8,403,000 x .00989)	83,100
Additional Annual Maintenance	4,100
	$ 307,800

Estimates of Benefits

80. Improvement of Portland Harbor will result in considerable annual benefits. These benefits will be realized from existing and prospective commerce, both in crude petroleum and refined petroleum products. Commerce in crude is largely overseas traffic both from the mid-East and South America. For this type of traffic, shippers endeavor to reduce transportation costs by using larger tankers. The larger tankers, now in use or being constructed for this commerce, cannot be utilized in the Portland Harbor trade, as the present navigational facilities are inadequate for their use. With improvement, the larger tankers, specifically those in the 55,000 to 73,000 deadweight ton class, will be able to use the harbor. As the cost of transporting oil in these larger vessels is lower than in the smaller vessels, annual savings in transportation costs will be realized for that portion of the prospective commerce to be carried in the larger type of vessel. For the smaller tankers, which are in the 35,000 - 45,000 deadweight ton class, no benefits in transportation savings will be realized, as these vessels can now use the harbor over high water periods. However, improvement of navigational facilities will benefit these vessels by enabling navigation of the harbor of any stage of the tide. Therefore benefits will be derived from elimination of the tidal delays. Further benefits will be derived from provision of sheltered anchorage within the harbor itself. The present anchorage for deep draft vessels is in Hussey Sound outside the main harbor. Utilization of this anchorage often results in considerable weather delays. Extra operating costs are also involved. With improvement of inside anchorage these delays and costs will be eliminated resulting in additional benefits.

81. As discussed in the section of this report entitled, "Existing and Prospective Commerce," the crude oil movement in the harbor is estimated to increase to 24,000,000 tons. This movement will be carried in tankers varying from 35,000 to 73,000 deadweight tons. Due to the inherent difficulty of forecasting movement of commerce by specific class, it was considered that representative vessel classes would provide a fair basis for the average movement of vessels. The 60,000, 45,000, and 35,000 deadweight ton classes were used in computation of benefits. It was estimated also, that each class would carry an equal amount of the prospective commerce or 8,000,000 tons each.

82. Transportation savings for the commerce in the 60,000 deadweight ton vessels were computed. Ports of origin included the Mediterranean areas, the Persian Gulf, and South America. Benefits computed from savings from these areas were $580,000, $1,280,000 and $240,000 respectively, for a total of $2,100,000. The present worth of this benefit was computed as $1,464,000 annual benefit. This benefit is considered to be attributable to the channel and maneuvering area. It was also considered that these vessels would be subject to weather delays and extra costs, should inside anchorage not be provided. At the present time larger vessels anchor in

Hussey Sound outside the main harbor. At this anchorage outlying fog often sets in, rendering navigation impossible from Hussey Sound to the main harbor. At these times navigation inside the harbor is feasible. Considerable delay has occured from this source. For the expected vessel trips an estimated 264 hours would be saved by provision of inside anchorage. Hourly operating costs for this class of vessel are $300. Thus $79,200 savings could be realized from this source. Extra costs include $350 extra pilotage, and $50 launch hire. It is estimated that 85 ships would require anchorage. Therefore elimination of outside anchorage would result in savings of $34,000 from this source. The combination of savings $79,200 plus $34,000, or $113,200, which reduced to its present worth results in annual benefits of $79,700 to ships in the 60,000 ton class attributable to provision of inside anchorage.

83. The 45,000 deadweight ton tankers will not incur transportation savings, as it is now possible for these vessels to enjoy partial use of the harbor. Improvement will enable the vessels to utilize harbor navigational facilities at all times. This will be made possible by deepening the channel so that vessels can enter at all times without having to wait for tide. Present tidal delays were computed for these ships. The computation entailed consideration of the fact that some vessels may arrive at the harbor entrance at high water and proceed without delay to final destinations. Others may arrive at unfavorable tidal conditions and be forced to wait for various periods of time until navigation was possible. Utilizing mean tide curves for the locality, it was found that the average delay for all ships of this 45,000 dwt class is 1.7 hours per vessel trip. It was estimated that 170 trips of these vessels would be used in the prospective commerce. The savings thus would be 170 x 1.7 x $245, hourly operating cost, for a total of $70,800, or at present worth $49,800 annual benefit attributable to channel and maneuvering basin. These vessels, similar to the 60,000 deadweight ton vessels, discussed previously, incur anchorage delays and extra costs for the present anchorage. Computation of the savings in this respect reveals savings of $141,600, which reduced to present worth results in annual benefits of $99,800 attributable to improvement of anchorage.

84. Computation of the savings to be derived for the 35,000 deadweight ton vessels carrying crude oil to the Portland pipeline were made in a similar manner as the 45,000 deadweight ton vessels. The estimated savings for these vessels, reduced to present worth, result in annual benefits of $16,100 for the channel and $80,200 for the anchorage.

85. The benefits thus far shown all result from prospective commerce in crude oil. Additional benefits will result from commerce in refined petroleum products. The benefits attributable to the plan of improvement, only, will be discussed in this section. Benefits were computed for deepening the present 35-foot channel in Fore River, but were found to be insufficient to economically justify improvement of that portion of the

waterway. For the plan of improvement no benefits can be realized from channel deepening, as the present controlling depth of 38 feet is sufficient for these vessels. However, benefits for the anchorage basin can be realized. Elimination of weather delays and extra costs will result in savings of $101,200, which at present worth results in annual benefits of $41,100

86. In addition to the benefits computed above, intrinsic benefits not susceptible of monetary evaluation will be realized. These benefits would provide room for vessels in case of sudden emergency, a place to remove oil laden tankers from possible waterfront fire hazard, and a place of refuge from storms.

87. Details of benefits are described more fully in Appendix "B" of this report. Tabulated below is a summary of the benefits to be realized from improvement.

Summary of Benefits

	45'-Channel and Maneuvering Basin	45' Anchorage	Total
Transportation Savings (60,000 dwt vessels)	$1,464,000		$1,464,000
Elimination of Anchorage Delays (60,000 dwt vessels)		$79,700	79,700
Elimination of Tidal Delays (45,000 dwt vessels)	49,800		49,800
Elimination of Anchorage Delays (45,000 dwt vessels)		99,800	99,800
Elimination of Anchorage Delays (35,000 dwt) Crude Oil Commerce		80,200	80,200
Elimination of Tidal Delays (35,000 dwt) Crude Oil Commerce	16,100		16,100
Elimination of Anchorage Delays Anticipated Fore River Traffic		41,100	41,100
Total	$1,529,900	$300,800	$1,830,700

Comparison of Benefits and Costs

88. Comparison of the estimated annual benefits of $1,830,700 to estimated annual charges of $307,800 results in a benefit-cost ratio of 6.0 to 1.0.

Proposed Local Cooperation

89. The benefits to be derived from improvement of Portland Harbor are general in character. In view of this fact, it is considered that no local cash contribution toward first cost of construction of the project should be required. However, it is considered that local interests should hold and save the United States free from damage due to construction and subsequent maintenance of the project, and provide without cost to the United States, all lands, easements, and rights-of-way necessary for construction and maintenance of the project. It is anticipated that shore access will be required only for supplies and range markers. It is anticipated that dredging will be accomplished by bucket dredging with disposal of waste materials at sea. If it is determined after detailed studies that spoil-disposal areas are needed, local interests should, upon request of the Chief of Engineers and without cost to the United States, furnish any such areas required including such dikes, bulkheads and embankments as may be necessary for the initial construction and subsequent maintenance. Local interests have provided reasonable assurances that the requirements of local cooperation will be met. In addition the Portland Pipeline Corporation has given assurances that its berths and approach channel will be deepened to project depth. The costs of such deepening will be self-liquidating.

Apportionment of Costs Among Interests

90. The total cost of construction is estimated to cost $8,403,000 for initial construction and $4,100 additional maintenance. Of these amounts the Corps of Engineers has been apportioned $8,375,000 for initial construction costs, including $35,000 preauthorization study costs, with $2,500 additional annual maintenance required. The United States Coast Guard apportionment is $28,000 for initial construction costs with $1,600 additional maintenance for navigation aids.

Coordination with Other Agencies

91. All Federal, State and local agencies interested in the development of waterways in general and Portland Harbor in particular were notified of the public hearing held 16 December 1958 at Portland, Maine. The Maine Port Authority was consulted during the study.

92. The U. S. Fish and Wildlife Service has been notified and has no objection to the proposed improvement. Their report is contained in Appendix D of this report.

Discussion

93. Portland Harbor, Maine, the second largest commercial harbor in the New England area, is also one of the more improtant national harbors engaged in petroleum commerce. Statistically, its rank is second of all harbors receiving foreign crude petroleum in the United States. It received a total of about 12,900,000 tons of crude petroleum in 1959. This total compares with a total of about 3,300,000 tons received in 1949 and represents an increase of almost 300 percent.

94. Commerce in crude petroleum has undergone a radical change over the last 10 or 15 years. This change is considered due primarily to discovery and development of new sources, which are more distant than most domestic sources. As the cost of transportation from these new sources became more significant in the overall economy of the commerce, methods of reducing the transportation costs had to be devised. One method of economizing entailed the reduction of round trip time for the large tankers carrying the commerce. This was effected by reducing pumping time at both loading and unloading terminals. A second method consisted of increasing the size of the carriers in order that the number of round trips required for delivery of a specific total of commerce might be reduced. This method proved successful far beyond original expectations.

95. Tanker sizes during World War II and the period immediately thereafter were confined almost completely to those of about the T-2 class. This size had a cargo carrying capacity of about 16,000 to 17,000 tons and a speed of about 14 knots. Newer tankers, with somewhat larger cargo capacities and more speed were introduced into the petroleum trade about 1948 or 1949. It was found that these tankers could deliver considerably more commerce annually than the T-2's with little increase in operating costs. Thus considerable savings in transportation costs were derived from the larger vessels, particularly those engaged in foreign trade. After the success of the slightly larger ships became apparent, shipping companies began to build even larger ships. The trend toward building of larger and larger ships was accented by discovery and development of new sources of oil in the mid-East area. The larger ships in this trade were somewhat hampered by the navigational limitations of the Suez Canal. However, it was found that correspondingly larger ships could traverse the route from the Persian Gulf and Red Sea areas around the Cape of Good Hope and deliver the oil more economically. As an indication of the size of ships currently being constructed for this trade, the "Marine Engineering Log," August 1960 issue, lists tankers being constructed in U. S. shipyards as of 1 July 1960. A total of 12 tankers was under construction. Of these, one was a T-2 and the remainder in excess of 45,000 deadweight tons, with the largest being 106,000 deadweight tons.

96. Until recently Portland Harbor has been able to keep pace with the trend toward the use of larger vessels. This, in part, is due to its relatively deep entrance channel, having a controlling depth of 38 feet, throughout most of its area. This channel was ample for vessels having drafts of 33 or less feet. But as ships grew larger and longer, navigation became more difficult due to the presence of high spots in or near the natural channel. In order to avoid the high spots the larger vessels had to steer a course, which, with the prevailing tidal currents, tended to propel them toward the South Portland shore. The only alternative to this procedure was to navigate the channel at or near high water, when tidal currents were practically non-existent and

there was sufficient depth to give adequate hull clearance. The maximum size tankers that local pilots will take into the harbor under present conditions are 45,000 deadweight ton vessels, and then only under the most favorable weather conditions. These vessels are 736 feet long, 102 feet in beam, and draw 38 feet, loaded summer draft. In spite of the difficulties experienced by these vessels, their use is increasing annually, due to the transportation savings to be derived. Shippers, delivering the crude petroleum, have indicated their proposed use of vessels of the 55,000 to 73,000 deadweight ton class should improvement of the harbor be made.

97. The trend toward using larger tankers has also had its effect on coastwise trade in petroleum products. Recognizing the savings to be attained by using larger than T-2 tankers, shippers, engaged in this trade, have steadily increased the size of the carriers to a point where T-2's are becoming obsolete. In Portland this trend, until recently, has not been as pronounced as in other ports along the Atlantic seaboard. The apparent lag in keeping pace with the use of larger tankers has resulted from inadequacy of some terminals in the waterway to accommodate the larger vessels. This condition is rapidly being corrected. Some of the terminals have recently been modernized and permits to expand others have been granted. Therefore it is considered that the prospective commerce in petroleum products will be carried in considerably larger tankers than at present. It is estimated that the size of these ships will be about the 35,000 deadweight ton class as, due to the horizontal clearance limitations of the Portland Bridge, larger vessels will not be able to reach the terminals.

98. All of the vessels described above would be hampered by present navigational conditions. Vessels larger than 45,000 deadweight tons would be denied entrance to the harbor, because of the unsafe navigational conditions. Vessels ranging from 35,000 to 45,000 deadweight tons would incur delays resulting from tide, fog and weather. The larger ships are also hampered by inadequate anchorage space within the harbor. Vessels requiring anchorage are either forced to wait in the fairway or proceed to Hussey Sound. Both of these procedures entail extra costs which could be eliminated by provision of sheltered anchorage inside the harbor. These factors, resulting in higher transportation costs would be reflected in the general economy of the area served by the commerce.

99. All of the commerce in crude petroleum is received at the Portland Pipe Line Corporation terminal. The company then transhipps it to East Montreal, Canada, serving as a common carrier for 6 refineries in that area. The company is a United States Corporation incorporated under the laws of the State of Maine. It is interstate in character the lines running through Maine, New Hampshire and Vermont, where it connects with lines running directly to refineries at Montreal. Formerly, all of the crude was carried to its destination by way of the St. Lawrence River in smaller tankers. This procedure became inefficient, as that waterway was

icebound for about 5 months of the year. It also imposed a limitation on the size of vessels the maximum being 32,000 deadweight tons. The pipeline overcame the deficiencies. Portland is ice-free throughout the year and as the demand grew greater and ships became larger, the movement through Portland became more economical. Therefore it is considered that eventually practically all of this commerce will go via the pipeline. The commerce in petroleum products is entirely handled at Fore River terminals.

100. Improvement of the harbor will facilitate the movement of an estimated 29,500,000 tons of crude petroleum and petroleum products into the harbor at the end of project life. Of the total prospective commerce 24,000,000 tons are estimated as crude, and the remaining 5,500,000 tons petroleum products. Commerce in crude petroleum is expected to show a decided increase in the first few years after improvement and then decelerate slightly to keep pace with the normal demand. Commerce in petroleum products is anticipated to increase at a rate commensurate with normal factors such as population growth and new uses of the products.

101. The plan of improvement will provide adequate navigational facilities for vessels carrying the prospective commerce into the harbor. It will not fulfill the entire improvement requested by local interests. Deepening and enlarging the existing 30-foot anchorage was studied and found not to be justifiable, economically. It was found that deepening the existing 30-foot anchorage to 35 feet and enlarging it to the area requested would involve costs of about $18,000,000. Deepening the area within the existing limits, only, would cost about $5,000,000. Insufficient benefits could be found to justify either phase of the plan. Similarly, costs of providing an alternate 45-foot entrance channel from Hussey Sound to the harbor were investigated. It was found that the provision of such a channel would incur costs of about $11,000,000. Benefits for such a channel appear to be decidedly inadequate to justify such a cost. Therefore no further consideration was given to this aspect of improvement. Subsequent to the public hearing, a request was made by local interests, relative to the merits of deepening Fore River from its present depth of 35 feet to a depth of 37, 38 or 40 feet. Studies were made of the various depths. It was found that benefits for any of these alternative depths were inadequate to justify the proposed Fore River channel deepening.

102. Benefits were evaluated for the plan of improvement selected. Estimated benefits for the 45-foot entrance channel and maneuvering basin were found to total $1,529,900. For the anchorage benefits were estimated to be $300,800. The sum of these benefits, $1,830,700, compared with annual charges of $307,800 results in a benefit-cost ratio of 6.0.

103. The benefits to be obtained from the improvement of Portland Harbor are considered to be significant in the future general economy of Portland and the areas which its commerce serves. In the past, the

general economy was aided by such commerce, through construction of terminals, pipelines, wharves and other appurtenances. It is bolstered annually through maintenance and operation of the facilities through which the commerce moves. Future increases of commerce will require expansion of such facilities and their operation to accommodate the increased commerce with consequent benefit to the area. At the present time operation and maintenance of the pipelines and terminal alone is estimated to cost about $4,200,000. annually. This sum, combined with local, State and Federal taxes is estimated to cost about $6,000,000. annually. In addition, the servicing and supply of vessels, plus extraneous other expenses is estimated to average between $2,000,000 and $3,000,000 annually. It is anticipated also that the benefits derived for the petroleum products will contribute to the general economy. In addition, the pipeline operation is considered indispensable to future movements of petroleum commerce. It is conceivable that continued exclusion of the larger ships, which will be used more extensively in the future, would place the harbor in a less competitive position than other areas, which in effect could cause abondonment of the Portland operation. Therefore, improvement is believed to be necessary for the continued importance of the harbor.

Conclusion

104. The Division Engineer concludes that the present entrance channel and 35-foot anchorage area are inadequate for the present vessels engaged in petroleum commerce in Portland Harbor, and by their inadequacy precludes the use of larger vessels which are now becoming more prevalent in overseas commerce. He further concludes that: provision of an alternate channel, 45 feet deep, is not justifiable economically, that deepening and enlarging the 30-foot existing anchorage and that deepening the 35-foot Fore River channel is not justifiable at this time. He believes that the existing project for Portland Harbor should be modified to provide adequate navigational facilities for the larger ships. He considers the proper modification to consist of an entrance channel 1,000 feet wide and 45 feet deep and a combination maneuvering basin and anchorage in the site of the existing 35-foot anchorage and of the same depth as the channel. The modification of the project can be accomplished at a cost of $8,340,000., with $28,000. for additional aids to navigation. Since the benefits to be derived are for the general benefit of navigation, it is concluded that no local cooperation in the form of a cash contribution should be required.

Recommendation

The Division Engineer recommends that the existing project for Portland Harbor be modified to provide for an entrance channel 1,000 feet wide, 45 feet deep from deep water in Casco Bay to a line about opposite Fort Georges, and a 45-foot deep combination maneuvering basin and anchorage in the site of the existing 35-foot anchorage, all as shown on the map accompanying this report; the modification to be accomplished at an estimated cost of $8,340,000, plus $28,000. for additional aids to navigation; subject to the requirement that no construction work on the project modification shall be accomplished until local interests agree to hold and save the United States free from damages due to the

construction and maintenance of the improvement, obtain all land, easements, and rights-of-way necessary for construction and maintenance of project, and agree to furnish spoil disposal areas upon request of the Chief of Engineers if it is determined after detailed studies that such areas are necessary, and without cost to the United States furnish any such areas required including such dikes, bulkheads, and embankments as may be necessary for the initial construction and maintenance of the project. The total estimated cost of construction of the project is $8,340,000., with $28,000. for aids to navigation, $2,500. additional channel maintenance and $1,600. additional maintenance for aids to navigation.

KARL F. EKLUND
Colonel, Corps of Engineers
Acting Division Engineer

CORPS OF ENGINEERS

U. S. ARMY

DESIRED IMPROVEMENT
NOT RECOMMENDED
ENLARGE AND DEEPEN
30-FT. ANCHORAGE TO 35 FT.
DEEPEN TO 35 FT.

DESIRED IMPROVEMENT
NOT RECOMMENDED
DEEPEN 35-FT. CHANNEL
TO 37, 38 OR 40 FT.

DESIRED IMPROVEMENT
RECOMMENDED
CHANNEL 1000 FT. WIDE, 45 FT. DEEP
ANCHORAGE AND MANEUVERING BASIN
45 FT. DEEP

DESIRED IMPROVEMENT
NOT RECOMMENDED
CHANNEL, 45 FT. DEEP

HALFWAY RK.
30' APPROACH CHANNEL
POMROY RK.
FISH PT.
EXISTING 30' ANCHORAGE
DIAMOND I. LEDGE
FT. GORGES
LIMIT OF 45' CHANNEL
EXISTING 35' ANCHORAGE
45' CONTOUR
Flood
Ebb
54 EXISTING PROJECT
SPRING PT. LT. BREAKWATER
1100'
600'
1000'
35' CHANNEL
PORTLAND
MAINE STATE PIER
PORTLAND PIPELINE INC. PIER NO. 1 PIER NO. 2
CALSO OIL
USCG
RIVER
PORTLAND BR.
TIDEWATER OIL
RICHFIELD OIL
SHELL OIL
PROJECT LIMIT
35' CHANNEL
FORE
35' TURNING BASIN
GULF OIL
SOCONY MOBIL
AMERICAN OIL
TEXAS CO.
SOUTH PORTLAND
GREAT DIAMOND I.
LITTLE DIAMOND I.
HUSSEY SOUND
COLLEGE I.
45' CONTOUR
PUMPKIN NOB
40' SOLDIER LEDGE CHANNEL
EXISTING PROJECT
PEAKS I.
HOUSE I.
WHITEHEAD PASSAGE
CUSHING I.
RAM I.
RAM I. LEDGE
N

NOTES:
Soundings shown thus 35 are in feet and refer to the plane of Mean Low Water.
Existing project shown thus: ——
Desired improvement shown thus: ——

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.

PORTLAND HARBOR
MAINE

SHEET 1 OF 1 SCALE IN FEET
1000 0 1000 2000 3000

APPROVED
CHIEF, ENGINEERING DIVISION
SUBMITTED
CHIEF, PLANNING AND REPORTS BRANCH
OR BY
CHIEF, RIVER AND HARBOR SECT. TRIYADC
PROJECT ENGINEER

TO ACCOMPANY SURVEY REPORT DATED SEPT. 15, 1960

FILE NO. 1650 D-1-4

APPENDIX A
COMMERCE

1. Existing Commerce. - Portland Harbor ranks second in the nation in receipts of crude oil, its commerce in that commodity totaling 11,647,404 short tons in 1958. This total represented 75 percent of the total commerce of 15,590,854 short tons for the port. The Portland Pipeline Inc. reported a total of 12,888,169 short tons of crude oil for 1959. The crude is received at the Portland Pipeline Inc. terminal and transhipped via two pipelines to Montreal, Canada. At the present time these pipelines service 6 refineries.

2. The Portland Pipeline Inc. is a United States Corporation, incorporated under the laws of the State of Maine. Its lines run through 3 states, Maine, New Hampshire, and Vermont, connecting with the Montreal Pipeline Company Limited lines at the International Boundary Line, North Troy, Vermont. It has 6 pumping stations, including the main pumping station at South Portland. The pipeline began operations in 1941 with one 12-inch line. Primarily its purpose was to deliver oil to 4 refineries in Montreal during the off-season of the year. Prior to establishment of the line, the oil was delivered by tanker via the St. Lawrence River. As this waterway is usually ice-locked during a 5-month season, the pipeline was able to fill the void by assuring delivery of crude oil through the entire season. The original capacity of the pipeline was in the vicinity of about 65,000 barrels per day. The pipeline operation became so successful, particularly with the post-war trend to transporting crude oil in larger tankers, that in 1950 an 18-inch line was added parallel to the original line. This line increased the capacity of transportation to about 275,000 barrels daily. Receiving tankage at the South Portland terminal was expanded to 2,200,000 barrels. Also, to provide for the larger vessels the company erected a second pier. This pier was designed to handle tankers of the 60,000 to 65,000 dwt class.

3. With the installation of the second pipeline, commerce in crude oil began to increase steadily. For the 10-year period beginning in 1949, receipts increased from a total of 3,267,961 tons, in that year to a total of 11,647,404 tons in 1958, or by 256 percent. As the commerce increased the capacity of the lines was increased by adding loops at various points along the line. The company has stated that as the need arises, capacity of the line, together with expansion of facilities, will be increased. It further stated the addition of a third line will eventually be necessary as commerce increases.

4. It is considered that the pipeline may be classified as a common carrier. It began operations with four companies utilizing its facilities. A fifth refinery was included sometime after the project was completed, and the sixth was connected to it in 1959.

The Pipeline Corporation has stated that its facilities are available to any other refinery which may wish to connect to the pipeline. The six refineries now using the facility are Imperial Oil Limited, The British American Oil Company Limited, McColl-Frontenac Oil Company Limited, Shell Oil Company of Canada, Limited, Canadian Petrofina Limited, and British Petroleum Company of Canada, Limited. The combined capacity of the six refineries is somewhat in excess of 300,000 barrels per day.

5. Table No. 1 below shows commerce in crude oil for the period 1949-1959.

Table I

Year	Commerce (Crude Oil)	% Increase Over Prev. Yr.
1949	3,267,961	
1950	4,184,141	+ 28
1951	6,774,500	+ 62
1952	7,636,016	+ 13
1953	8,058,041	+ 6
1954	8,093,235	+ 0.4
1955	10,351,382	+ 28
1956	11,699,012	+ 13
1957	12,569,446	+ 7
1958	11,647,404	- 7
*1959	12,888,469	+ 10

* Reported by Portland Pipeline Inc.

The decline in 1958 receipts is considered to be attributable to irregularities of shipping over the winter period. Preliminary records of 1959 receipts indicate a substantial gain over the 1957 traffic similar in detail to 1955-56 percentage variance.

6. In addition to the crude oil, described above, petroleum products are a substantial factor in the commerce of the port. These products are distributed over southern Maine, and parts of New Hampshire and Vermont. The 1949 commerce was 2,266,552 tons and the 1958 commerce 3,164,336 tons of such products. This represents an increase of 40 percent for the ten-year period. All of this commerce is carried to Fore River which has an existing project depth of 35 feet. In past years T-2 or smaller vessels carried this commerce. However, during recent years some of the terminals have started using larger ships in order to take advantage of the more economical transportation rates in these ships. Other terminals have applied for permits to enlarge their terminals sufficiently to receive the larger ships.

7. Various other commodities are carried in the waterway among which are bituminous coal, clays and earth, scrap iron, wheat flour, grain and other products. The annual commerce for the most recent 10-year period is tabulated below, together with a detailed statement of commerce for the year 1958.

TABLE II

Comparative Statement of Traffic

Year	Tons	Passengers	Year	Tons	Passengers
1949	6,847,619	570,677	1954	11,782,242	436,808
1950	7,824,564	614,808	1955	14,218,466	433,419
1951	10,317,208	439,476	1956	15,890,156	343,695
1952	11,302,302	483,221	1957	16,437,062	419,555
1953	11,750,502	456,570	1958	15,590,854	375,415

Freight Traffic, 1958
(Short Tons)

	Commodity	Total	Foreign			Domestic Coastwise	
			Imports	Exports	Receipts	Shipments	Local
	Total	15,590,854	12,150,111	96,205	2,883,959	423,203	37,376
037	Cheese	12	12				
040	Fish and products, fresh	37,808		184	3,115	614	33,895
043	Fish and products, canned	36		26		10	
045	Fish and products, nec	79			79		
049	Shellfish and products	2					2
055	Edible animal products, nec	2			2		
095	Animal products, inedible, nec	834			834		
100	Corn	11,704		11,704			
103	Wheat	2,800		2,800			
107	Wheat flour	21,663		21,663			
140	Nuts and prep	10		10			
421	Wood manufactures, nec	333		333			
441	Wood pulp	32,878	31,228	1,645		5	
450	Standard newsprint paper	31,344		31,344			
457	Paper and mfrs, nec	2,503	101	2,402			

Freight Traffic, 1958(Cont)
(Short Tons)

	Commodity	Total	Foreign		Domestic Coastwise		
			Imports	Exports	Receipts	Shipments	Local
502	Bituminous coal and lignite	492,218			492,218		
505	Gasoline	1,254,538	13,840		1,006,088	234,007	603
510	Gas oil, distillate fuel oil	955,828			846,728	107,073	2,027
511	Petroleum, crude	11,647,404	11,647,404				
513	Kerosene	405,429			347,882	56,888	659
514	Residual fuel oil	516,275	378,987		136,741	547	
516	Petroleum asphalt	15,222	15,222				
519	Lubricating oils and greases	1,404			1,404		
520	Petroleum products, nec	15,640			5,818	9,822	
540	Clays and earths	62,431	62,431				
550	Sulphur	32,982			28,222	4,760	
555	Nonmetallic minerals, mfrs nec	61		61			
602	Iron and steel scrap	23,265		23,265			
609	Rolled, finished stl mill prod	6,111	883		5,228		
612	Metal mfrs and parts, nec	2,664			2,661	3	
722	Const., mining mach., parts	168		168			
740	Textile, shoe mach., parts	423		423			
742	Industrial mach., parts, nec	3				3	
783	Watercraft and parts	3	3				
800	Coal-tar products	5,600			3,394	2,206	
900	Commodities, nec	11,000			3,545	7,265	190
* 980	Low-valued shipments	177		177			

* The error due to sampling is between 51 and 79 percent.

8. Prospective Commerce. - As stated previously, (Paragraph 3 of this Appendix) commerce in crude oil increased by 256 percent over the period from 1949 to 1958. This rate of increase is not expected to prevail over the anticipated life of the project. The rate is considered abnormal and

attributable largely to two causes, both inter-related and dependent on each other. The first is considered to result from a transition of a large portion of the crude oil movement from the all-water route via the St. Lawrence River to the Portland Harbor pipeline route. The second is considered to result from increased and more varied uses of petroleum products, inducing a greater movement of crude oil to the Montreal area than could be handled by the St. Lawrence only.

9. As commerce increased it was the purpose of the original 12-inch pipeline to augment the water route during the summer months and to serve as a source of supply during the 5 winter months when the river was ice-locked. However, in the postwar period, the uses of petroleum products increased to such an extent that an increase in transportation facilities to the refineries had to be made. During that time also the movement of oil, particularly crude, began to move in larger carriers. The larger carriers could not utilize the St. Lawrence waterway, as the navigation facilities restrict shipping to a maximum size tanker of the 28,000 to 30,000 dwt. Portland Harbor can handle a 45,000 dwt vessel, with some attendant tidal delays. Therefore the 18-inch pipeline was installed and the terminal at South Portland enlarged to receive these vessels. Also as both the commerce and size of the vessels increased it was found that costs of transportation in the all-water route and the alternate Portland route began to equalize at a point somewhere in the vicinity of the 40,000 dwt tanker movement to Portland. With the use of over 40,000 dwt tankers to Portland it is considered that more economical transportation can be made, the amount of transportation savings dependent on the size of the carrier.

10. It is considered that at this time the transition of routes is practically complete, with the pipeline carrying the major portion of crude oil. Exact statistics on the amounts carried over each route are not available. Some indication of such amounts may be gleaned from a statement of the Portland Pipeline Corporation, which indicated that 85 percent of the summer traffic and all of the winter traffic is routed through the pipeline. It is anticipated that in future movements, the Portland trade will be augmented by part of the remaining St. Lawrence commerce, as the larger ships are utilized.

11. In view of the above, commerce in crude oil will increase over the anticipated life of the project. It is expected that part of the trade now utilizing the St. Lawrence River will be diverted to Portland, as the use of the larger tankers becomes more general. This will undoubtedly show a decided increase in the first few years of the project life and then level off to keep pace with normal increases, such as population increases, and related factors. The normal increase for the area served is expected to be as great or greater than the overall national increase, as this area is comparatively well-populated.

12. Domestic demands for refined petroleum products, both United States and Canadian, have shown marked increases in recent years. For the period 1949 through 1958 the United States demand increased 56.2 percent. For a somewhat shorter period, 1950 to 1957, Canadian demand increased by 96.5 percent. These rates of increase are not expected to remain constant over the life of the project, but are cited to show recent trends which are considered will carry well into the project life. It is conservatively estimated that Portland Harbor commerce in petroleum (crude oil) will increase to a total of 24,000,000 tons 50 years after improvement. This estimate is based on curves showing past increases, with allowances made for shifts of population, decreases in the sources of supply, and the opening of new sources which would utilize different modes of transportation. It is also estimated that commerce in petroleum products will increase to a total of 5,500,000 tons. Tables 3 and 4 show annual demands for refined petroleum products. Table 5 shows the percent of world proved reserves in 1958.

13. As discussed previously the Portland Pipeline Corporation is now operating at about its full capacity, the capacity of the refineries and the pipeline being about the same, taking into consideration the crude received by water. In view of the more economical transportation of oil to Portland in the larger ships, it is expected that the capacity of the pipelines will be increased to meet future demands. The Portland Pipeline Corporation has stated that it will enlarge its facilities, as circumstances warrant it, citing as evidence its past record of expansion.

TABLE 3

U. S. Petroleum Domestic Demand*
Refined Products

Year	Total (1,000 barrels)	Increase	Percent Increase (Over Prev. Year)
1949	2,118,250		
		256,807	12.1
1950	2,375,057		
		194,770	8.2
1951	2,569,827		
		94,580	3.7
1952	2,664,407		
		110,914	4.2
1953	2,775,321		
		57,103	2.1
1954	2,832,424		
		255,531	9.0
1955	3,087,775		
		125,412	4.1

TABLE 3(Cont)

U. S. Petroleum Domestic Demand*
Refined Products

Year	Total (1,000 barrels)	Increase	Percent Increase (Over Previous Yr.)
1956	3,213,187		
		5,432	0.2
1957	3,218,619		
		89,997	2.8
1958	3,308,616		

% Increase 1958 Over 1949 = 56.2%
* A.P.I. Facts and Figures (1959)

TABLE 4

Canadian Domestic Demand*
(Refined Petroleum Products)

Year	Total (1,000 barrels)	Increase	Percent Increase (annually)
1950	118,383		
		15,501	13.1
1951	133,884		
		15,360	11.5
1952	149,244		
		13,993	9.4
1953	163,237		
		17,650	10.8
1954	180,887		
		19,255	10.6
1955	200,142		
		30,293	15.1
1956	230,435		
		2,232	0.1 (incomplete)
1957	232,667		

Percent increase 1957 over 1950 = 96.5

* A.P.I. Petroleum Facts and Figures (1959)

TABLE 5

World Proved Oil Reserves (1958)

A.P.I. Petroleum Facts and Figures (1959)

Region	Percent of Total
North America	13.56
South America	7.08
Eastern Europe (Incl. Soviet Russia)	10.08
Africa	1.51
Middle East	63.67
Far East	3.71

14. Vessel Traffic. - Shipping interests, in order to effect more economical transportation of petroleum and its products, have been constructing larger tankers to carry these commodities. Such construction has been particularly noticeable in the crude oil movement from the mid-East and South America. The upward trend in tanker size has shown its impact on Portland Harbor. Prior to 1956 the largest vessels entering the harbor, had drafts of 35 feet. There were about 36 trips of such tankers in the preceding 5 years. Prior to 1949, the maximum draft of vessels was in the vicinity of 31 feet. In 1956 the larger ships were introduced into this trade, and trips became progressively more numerous each year. In 1958 the first 45000 dwt tanker made one trip. In 1959 about 7 of such trips were made, with about the same number in the first 7 months of 1960. All of the trips of vessels drawing 35 or more feet carried crude oil to the Portland Pipeline Terminal. The largest vessel utilizing Fore River had a draft of 32 feet. Table 6 shows the rise in larger vessel traffic over the past years. Table 7 shows a detailed breakdown of vessel traffic for 1958, the last year for which such statistics are available.

TABLE 6

Tanker Vessel Trips
(Inbound)

Draft(feet)	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959*
39											1
38										1	7
37									1	11	6
36							1	1	19	38	31
35			1		5	9	17	22	53	86	
34		14	26	18	17	40	72	81	68	86	
33	1	13	39	36	61	50	96	84	54	50	
32	10	44	97	81	87	79	92	89	82	78	
31	60	139	149	183	163	149	153	207	181	113	
30	140	101	102	153	167	150	117	131	179	81	
29	31	47	50	65	55	56	16	25	48	18	
28	12	24	25	36	25	15	14	10	15	6	Incomplete

* Estimated from shipping records

TABLE 7

Trips and Drafts of Vessels - 1958

Inbound

Draft(ft)	Self-propelled Vessels: Passenger and Dry Cargo	Self-propelled Vessels: Tanker	Self-propelled Vessels: Towboat or Tugboat	Non-self-propelled Vessels: Dry Cargo	Non-self-propelled Vessels: Tanker	Total
38		1				1
37		11				11
36		38				38
35		86				86
34		86				86
33		50				50
32		78				78
31		113				113
30	22	81				103
29	26	18				44
28	1	6				7
27	2	1				3
26	2	1				3
25	10	3				13
24	9	4				13
23	12	2				14
22	18	2				20
21	18	1		1		20
20	12			2		14
19	14	2				16
18 & less	10,673	777	20	3	5	11,478
Total	10,819	1,361	20	6	5	12,211
Total net register tonnage	1,002,429	5,815,540	2,923	11,269	5,995	(1) 6,838,136
Passengers						175,669

TABLE 7 (Cont)

Trips and Drafts of Vessels - 1958
Outbound

	Self-propelled Vessels			Non-self Propelled Vessels		
Draft(ft)	Passenger and Dry Cargo	Tanker	Towboat or Tugboat	Dry Cargo	Tanker	Total
38						
37						
36						
35						
34						
33						
32						
31						
30	1					1
29		1				1
28	1	3				4
27	2	4				6
26	3	10				13
25	6	41				47
24	12	60				72
23	13	119				132
22	19	77				96
21	10	58		1		69
20	16	112				128
19	34	40		1		75
18 & less	10,700	826	22	4	5	11,557
Total	10,817	1,351	22	6	5	12,201
Total net register tonnage	1,045,338	5,790,074	3,173	11,249	5,995	(1) 6,855,829
Passengers						199,746

Local

	Self-propelled Vessels		
Draft(feet)	Passenger and Dry Cargo	Tanker	Towboat or Tugboat	Total
18 and less	49	461	4	514
Total net register tonnage	764	11,222	20	12,006

(1) Excludes total net register tonnage for 200 vessels engaged in foreign trade

15. As an indication of the trend toward building larger tankers Table 8 below shows tanker construction of leading petroleum registries underway in 1958 (A.P.I. Petroleum Facts and Figures 1959).

TABLE 8

Tank Ships Under Construction
December 1958

Future Registry	No.	DWT	Av. DWT
United States	28	1,149,000	40,000
Canada	2	80,000	40,000
Greece	5	201,800	40,000
Kuwait	1	46,000	46,000
Liberia	98	4,709,900	48,100
Norway	150	4,486,200	30,000
Panama	45	1,547,800	34,900
United Kingdom	175	6,137,300	35,200
Venezuela	4	142,400	35,600
Unknown	38	1,790,600	47,100

From the above table it is apparent that a sizeable proportion of world tankers will be above 48,000, with most of the remainder between 35,000 and 47,000 dwt.

16. At this time it is considered that the largest tanker in the prospective commerce in the harbor will be a 73,000 dwt tanker with dimensions of 855 feet in length, 112.5 beam and slightly over 45 feet in draft. This size in combination with vessels carrying from 55,000 to 65,000 tons of crude oil is estimated to carry at least 33 1/3 percent of the prospective commerce over the project life. For the remaining 66 2/3 percent of the commerce, it is estimated that a combination of vessels carrying from 35,000 to 45,000 dwt will be used. This estimate is based partly on the statements of local interests and partly on records of new tanker construction over the past few years. Also since this commerce is exclusively overseas, it is considered that the larger ships will be used in this trade.

17. As an indication of the type of shipping to be used in the event of improvement the Portland Pipeline Corporation cited statements of shippers, who now deliver crude to their terminal. One company in 1957 stated that they now had 47,000 dwt vessels under construction, with dimensions of: length 740 feet, beam 102 feet and draft of 38 feet. These tankers will be used in the Portland trade should the harbor be improved to accommodate them. The company also stated that one of its affiliates was building vessels of the 73,000 dwt class which would be highly suitable for the Portland movement. Another company submitted a table showing the types of vessels it intended to use in Portland after improvement. These types were

cited as 40,000, 47,000, 60,000, and 64,000 ton classes. This company cited, "World Tanker Fleet Review, 30 June 1958," by John I. Jacobs Company, London E63, England. This company predicted that 15 percent of existing tankers would be in excess of 45,000 deadweight tons in 1963, all in overseas trade. Two other shipping companies cited similar classes of tankers to be used in Portland after improvement.

18. Prospective vessel traffic in petroleum products will also be carried into Fore River. However, there is a limitation on the size of vessels that can proceed above the Portland Bridge. This bridge has a horizontal clearance of 97 feet. The largest vessel that could proceed through this bridge would be a 35,000 dwt tanker having a beam of 93 feet. However, it is estimated that by the midpoint of project life, the inbound commerce will be carried in this class of vessel.

APPENDIX B
ESTIMATES OF BENEFITS

1. The benefits, estimated to result from improvement of Portland Harbor, will be derived from commerce in petroleum products. Specifically, the benefits will be realized from savings in transportation costs resulting from the ability to use larger vessels than can presently be used, savings in hourly operating costs to vessels by reduction or elimination of the present and anticipated tidal delays, and savings made possible by elimination of weather delays in provision of sheltered anchorage inside the harbor.

2. Over the anticipated 50-year life of the project considerable savings in annual transportation costs will result from improvement. These savings will be derived from use of vessels larger than the maximum size which can now be brought into the harbor without improvement. Local interests report higher costs for the maximum 45,000 dwt tankers than the larger vessels. These higher costs were investigated. Analysis of round trips from ports of origin revealed that transportation costs in this respect are $0.12 higher per short ton from South America, $0.29 higher for the Mediterranean area and $0.64 higher for the Persian Gulf. These costs were computed for fully loaded vessels. Lightening prior to harbor entry and partial loads were considered and found to entail higher transportation costs.

3. The average annual amount of savings that can be achieved by use of the larger vessels depends on several factors among which are: continuation of the trend toward construction of larger tankers, with resultant retirement of smaller ones, the future availability and number of the vessels, and the anticipated increase of commerce in Portland Harbor over the life of the project. The first factor, continuation of the trend, would appear to be basic, in view of the more economical cost of transportation. The only deterrent to continuation of such a trend stems from the present insufficiency of adequate harbors to receive them. Such insufficiency is now being studied and it is considered that, generally speaking, most of the important petroleum harbors in the country will have been improved sufficiently in the near future to receive the larger vessels. The second factor, availability, and number, is not considered to be particularly applicable to this harbor, as several of the shipping companies now servicing Portland have at present, or under construction, several of these larger vessels and have indicated their use in the Portland trade, should improvement be effected. Thirdly, an anticipated increase in petroleum commerce locally will stem from two sources, the savings that can be gained by the more economical Portland Harbor pipeline route versus the all-water route in the St. Lawrence waterway to Montreal, and the normal growth in the use of petroleum products, resulting from such factors as population increases, and new and more varied use of petroleum products.

4. The anticipated commerce will be partly carried in tankers larger than the maximum size now able to use the harbor. This will result in

substantial savings in transportation costs for that portion of the commerce carried in the larger tankers. However, it is considered that such savings could only be realized for that portion of the commerce destined for the oil terminals below the Portland Bridge. The reason for this consideration is based on the horizontal clearance of the draw-span of the bridge, which is 97 feet. This limitation precludes passage of any vessel larger than a 35,000 deadweight ton vessel having dimensions of 690 x 93 x 36.- foot draft. As stated previously, the maximum size vessels now using the harbor are somewhat larger, being 45,000 deadweight ton vessels with dimensions of 736 x 102 x 37.5 feet draft. Therefore only the anticipated commerce for the terminals below the bridge was considered in the computation of benefits to be realized from transportation savings.

5. At the present time there are three major oil terminals below the Portland Bridge, California Oil Company, Pocahontas Fuel Company and Portland Pipeline Corporation. Both California Oil Company and Pocahontas Fuel Company use the same docking facilities. At the time of the hearing California Oil Company indicated that it was then using T-2 tankers and was contemplating the use of 28,000 deadweight ton vessels in the near future. Pocahontas Fuel Company, also, has not indicated use of larger than 28,000 dwt vessels. Since it is possible to bring in this size and larger ships fully loaded at the present time under favorable tidal conditions, no benefits for transportation savings were estimated from this source. The Portland Pipeline Corporation presently uses the maximum 45,000 deadweight ton tanker for part of its receipts and has indicated the use of larger ships, in the event of improvement. The size indicated by the corporation ranged from 55,000 to 73,000 deadweight ton vessels. These vessels, in combination with smaller vessels, will carry a portion of the anticipated commerce to this terminal. As explained previously in Appendix A commerce is estimated to increase by an annual amount equal to about 2 percent of the 1958 commerce for a total of 24,000,000 tons in the final year of project life. It is estimated that of the anticipated commerce, about 8,000,000 tons will be carried in the larger ships. This estimate is based on authoritative records of tanker construction, underway in 1958, (American Petroleum Institute), which indicate tanker construction averaging 40,000 to 48,000 dwt for registry of 3 leading petroleum-carrying countries. This would indicate a large part of the current shipbuilding construction to be over 48,000 dwt.

6. Of 8,000,000 tons of crude oil to be carried in the larger ships, it is estimated that 50 percent or 4,000,000 tons will originate in the mid-East and the remaining 4,000,000 tons from South America. Present commerce indicates that the ratio of crude oil received from South America to that received from the mid-East is about 5 to 3. This proportion is not expected to continue in view of the strength of proved world oil reserves (API 1958) which indicate 64 percent for the mid-East

and 7 percent for South America. This would indicate an eventual larger supply from the mid-East, based on availability. The estimate of 50 percent considers supply from the mid-East on the basis of a world supply compared with the local supply from South America, a great portion of which is owned by the refiners concerned. For the purpose of this report and because of the inherent difficulty of forecasting the amount of oil to be carried in the various vessel-classes, it is considered that the average-size vessel larger than 45,000 dwt will be 60,000 deadweight tons. Benefits to be derived will consider the savings to be derived from the transportation of the 8,000,000 tons in this vessel class. Investigation of sources of supply from the mid-East reveals that part of the commerce originates in the Mediterranean area and part in the Persian Gulf. For the purpose of this report, the prospective mid-East commerce will be considered to be equal from both these areas. As stated previously, (Para. 2, this Appendix), the savings to be realized from the Persian Gulf is $0.64 per short ton. For the 2,000,000 tons from this source prospective savings will be $0.64 x 2,000,000 or $1,280,000. The savings to be realized from the Mediterranean area will be 0.29 x 2,000,000 or $580,000. From South America the savings will be $0.12 per short ton. For the 4,000,000 tons of prospective South American commerce the savings will be $0.12 x 4,000,000 or $480,000. Total savings from South America will be reduced by one-half as the shipping ports in that area will have to be improved to take these larger ships. Total savings will be $1,280,000 + $580,000 + $240,000 or $2,100,000. The cargo carrying capacities of these vessels are about 60,000 short tons from the Persian Gulf, 63,200 from the Mediterranean and 65,000 from South America. The average tidal delay for this class of vessel, with a draft of 41 feet, will be 0.5 hours. It will require 127 trips of these vessels to carry the anticipated 8,000,000 tons. Therefore, the total delay will be 64 hours. Operating costs for these vessels are estimated at $300 per hour. The total transportation savings will thus be reduced by the cost of tidal delays which will be 64 x $300 or $19,200. The benefits to be obtained will thus be $2,100,000 - $19,200 or $2,080,800.

7. As stated previously in Paragraph 11, Appendix A, commerce in crude oil is expected to show an accelerated increase immediately after the improvement and then tend to level off. Accordingly the benefits will be reduced to present worth on the basis of an accelerated growth at an interest rate of 2.625 percent. The factor for this reduction has been computed as 0.70396. The annual benefit will therefore be 2,080,000 x .70396 or $1,464,000 attributable to the 45-foot channel and maneuvering basin.

8. The 127 trips of 60,000 dwt vessels, mentioned in the preceding paragraphs can be docked at the outer wharves, only during a period of about 1 hour at high slack tide. This restriction was put on the larger ships because of past damage to some vessels resulting from the combination of swell and tidal current while docking. This procedure invariably means waiting for proper tidal conditions. If the time involved is only

an hour or two, the vessels usually wait in the fairway in the entrance. Otherwise anchorage at Hussey Sound is effected. Waiting in the fairway is not considered safe procedure, as it presents considerable hazards both from the standpoint of darkness or a sudden turn in the weather. It is considered that the vessels would proceed to Hussey Sound, unless sheltered anchorage inside the harbor was available. Records obtained from the local pilots for the years 1958, 1959, and part of 1960 indicate that in each year approximately 70 percent of the 40,000 dwt tankers were forced to wait in Hussey Sound. The remainder waited in the fairway prior to docking.

9. Hussey Sound extra costs would be involved. The extent and nature of the extra costs were investigated. It was found from past records and from conferences with local pilots and shipping interests that the extra costs resulted from about three sources, which consist of intermittent poor visibility, extra pilotage, and extra launch hire. The poor visibility, cited by local interests, is caused by fog which often shuts in the outer islands while allowing sufficient visibility for safe navigation in the harbor. The "Atlantic Coast Pilot" confirms this citation. Local pilots reported that, during one period of 15 anchorages of larger vessels in Hussey Sound, 6 vessels were delayed from docking by fog which shut in the outer islands and Hussey Sound. It was further stated that no delay would have been incurred by these vessels were they able to anchor in House Island anchorage during that period. The lost time incurred in these delays ranged from 12 to 36 hours. From investigation of Weather Bureau records during a 7-year period, it was found that fog occurs in Portland Harbor about 13 to 17 percent of the year, generally through the spring and summer months. These fog conditions were observed from shore stations and are not considered indicative of the conditions in the outer harbor. However, it represents a basis for determination of the incidence of such conditions. For the 127 trips of the larger vessels carrying the anticipated commerce it is estimated that 70 percent, or 85, would require anchorage at Hussey Sound. Of the anchorages in Hussey Sound, it is estimated that about 11 would incur fog delays, if forced to anchor in Hussey Sound. It is further estimated that these vessels would experience and average delay of 24 hours each for a total of 264 hours. The fog delays are considered extra and independent of tidal delays and are independent of transportation savings since these savings were computed for ideal navigation conditions. The average hourly operating cost for these vessels is estimated at $300. Thus the savings incurred by use of House Island would be $300 x 264 or $79,200, attributable to House Island anchorage.

10. Local interests report that extra costs incurred in using Hussey Sound include $50 launch hire, extra pilotage, averaging about $350 per trip and 2 to 4 hours running time to and from the anchorage. The combined launch and pilotage fees for the 85 trips would amount to $400 x 85 or $34,000. The extra pilotage cost is in addition to that incurred, if the vessel were brought into harbor, either at the dock or

House Island anchorage. In both cases towboats take over for the final docking operation. The extra running time is not considered to be extra costs, since the vessels would have to wait for slack water in either anchorage. The total savings attributable to use of the anchorage by 60,000 dwt tankers would be $79,200 + $34,000 or $113,200. Based on an interest rate of 2.625 percent the present worth becomes $113,200 x 0.70396 or $79,700.

11. It is estimated that the remaining portion of the prospective commerce in crude oil will be carried in a combination of tankers, ranging from 30,000 to 45,000 dwt with the greater proportion in the 35,000 - 45,000 dwt class. This estimate considers a vessel class that is somewhat higher than the prevailing vessels. The estimate is not considered unreasonable in view of the present navigational difficulties, and the continued increase in use of larger vessels in this commerce despite present navigational difficulties. The present trend toward using larger vessels is illustrated in records of the past 2 years. In 1958, a total of 21 tankers of 40,000 dwt or larger capacity visited the harbor. The total for 1959 was 45, and 38 in the first 7 months of 1960. Should the present average of 1960 be sustained, and there is no indication that it will not, a total of 65 such trips will be made. Since these trips are now made in an unimproved channel, it is considered that a larger proportion of them will be used immediately after improvement estimated by 1962. In combination with the 40,000 dwt or larger ships present commerce is carried in 30,000 to 39,000 dwt vessels. It is therefore considered that by the end of project life the lowest vessel class will be 35,000 dwt. It is also estimated that these vessels will carry an equal amount of commerce as the 45,000 dwt vessels. Thus of the remaining 16,000,000 tons of prospective commerce, 8,000,000 tons will be carried in 35,000 dwt tankers and 8,000,000 tons in 45,000 dwt tankers.

12. The amount of crude to be carried in the 45,000 ton vessels will amount to 8,000,000 tons, It is estimated that it will require 170 trips of these vessels to carry this volume of oil. As the vessels can now navigate the channel, subject to tidal delays, it is not considered that any transportation savings will be effected by these ships. However, they are now subject to tidal delays. The vessels draw 38 feet loaded summer draft which in the present channel are each subject to 1.7 hours average delay in still water. No delays from this source would occur in a 45-foot channel. The hourly operating cost for those vessels is estimated at $245. Therefore the annual average savings, due to reduction of tidal delays, would be $2.45 x 1.7 x 170 or $70,800 annual benefit attributable to the channel deepening. Present worth of the benefits is $70,800 x .70396 or $49,800.

13. At the present time anchorage for these ships is not available in the harbor, as they draw 3 feet over the present 35-foot depth in House Island. Therefore these ships would be subject to the same delays as the larger vessels in Hussey Sound. Of the 170 trips, 70 percent or 119 are

are considered to require anchorage in Hussey Sound. Delays due to extra pilotage and lauch hire equal $400. For the 119 trips this will total $47,600 an annual benefit attributable to provision of sheltered anchorage inside the harbor. It is considered also that of the 119 trips to be made about 13 percent or 16 trips would be subject to delays averaging 24 hours each due to fog. Thus the total delays from this factor would be 384 hours. At the hourly operating cost of $245 the total savings attributable to the anchorage from this source would be 384 x $245 or $94,000 annual benefit. It is considered that these benefits will, similar to the benefits for larger ships, accrue at an accelerated growth over project life. Therefore the benefits will be (94,000 + 47,600) x .70396 or $99,800.

14. The remaining prospective commerce in crude oil will be carried in 219 trips of the 35,000 dwt class. Since these vessels draw about 34 feet, it is considered that they will derive the same benefits for sheltered anchorage in the harbor as the larger vessels. While it would appear that a 35-foot deep anchorage would suffice for a ship drawing 34 feet, the fact is that greater allowance for hull clearance should be made. It is considered that an allowance of 3 to 4 feet should be made. The 3-feet would allow for swell, minus tides and uneven loading of the vessels. The benefits would, as in the case of the larger ships, consist of $400 per trip for elimination of extra pilotage and launch hire. It is considered that of the 219 trips 50 percent or 110 trips would require anchorage. The smaller 35,000 dwt tankers are considered not to require as high a rate of anchorage as the larger ships. Of the 110 anchorages required, 14 would be delayed by fog. Thus the savings similarly computed for the larger ships would be 14 x 24 or 336 hours. Hourly operating costs for these ships are $208. The savings would thus be $208 x 336 or $69,900. The total savings for these ships would thus be $44,000 plus $69,900 or $113,900. Therefore the total savings for these vessels would be $400 x 110 or $44,000 attributable to the anchorage. The benefit for these ships at present worth value is $113,900 x .70396 or $80,200.

15. Benefits will also be derived from deepening the channel. The average tidal delay for these vessels has been computed at 0.5 hours per trip due to channel controlling depth of 38 feet. For the 219 trips required, the total delay would be 110 hours which, when multiplied by $208 hourly operating cost for the vessel, gives a total of $22,900 which would be saved by deepening the channel. Present worth of this benefit is $22,900 x .70396 or $16,100. This benefit is considered to be attributable to the entrance channel and turning basin only.

16. Fore River commerce consists chiefly of receipts of petroleum products. Some shipments are made by barge traffic to nearby harbors. Since this traffic will not be affected by improvement no benefits will be estimated for this part of the Fore River commerce. Receipts of petroleum products in 1958 in deep draft ships totaled 2,750,000 tons. This total is anticipated to double over the life of the project. It is considered that the increase will be a straight line appreciation due to

such factors as population increases, and greater and more varied use of such products. As the increase is considered to be constant, a total of 5,500,000 tons by the end of project life was used in computation of benefits.

17. In addition to the anticipated commerce in crude oil, previously discussed, benefits will be derived from the prospective commerce in petroleum products. As the terminals receiving these products are located on Fore River, benefits for the outer harbor and Fore River would be realized. The benefits attributable to Fore River deepening have been estimated and found to be insufficient to justify economical improvement of that portion of the harbor. Benefits for the prospective commerce of 5,500,000 tons of commerce have been estimated on the basis of elimination of tidal delays in the present 35-foot channel. At the present time the average delay per trip is 2.0 hours for vessels of 34-foot draft. In a 37-foot channel the average delay would be 1.5 hours, in a 38-foot channel 0.8 hours and no delay in the 40-foot channel. To carry the prospective commerce of 5,500,000 tons at the end of project life would require about 146 trips of vessels carrying full cargo loads of about 37,600 short tons. The savings in vessel time due to reduction in tidal delays would be 73 hours in the 37-foot channel, 175 hours in the 38-foot channel and 292 hours in the 40-foot channel. These total delays, multiplied by hourly operating costs of $300 result in annual savings of $21,900, $52,500, and $87,600 respectively for the prospective commerce by the end of project life. Since these benefits are considered to be accumulated on a straight line basis present worth at 2.625 percent is taken as annual benefits. The benefits are thus estimated as $11,500 for the 37-foot channel, $27,500 for the 38-foot channel, and $45,800 for the 40-foot channel. These benefits compared with annual costs of 44,000, 96,965, and 146,000 result in B/C ratios of 0.31, 0.32 and 0.31 respectively indicating insufficient economical justification for deepening this channel. For this reason, benefits estimated for Fore River traffic in this report will consist only of those realized by improvement of the entrance channel and House Island anchorage.

18. At present, a combination of T-2 tankers, Jumbo T-2 tankers, and larger vessels carrying from 25,000 to 30,000 dwt, carry the petroleum products to Portland. This type of vessel is rapidly becoming obsolete, and is estimated to be practically non-existent by the end of project life. It is considered by that time that the commerce will be carried in tankers of about the 35,000 dwt size with a cargo capacity of 37,600 short tons fully loaded. This is the maximum size that can use Fore River above the Portland Bridge, as the 97-foot horizontal clearance of the bridge itself precludes passage of vessels of larger size. It will require 146 vessel-trips to carry the prospective commerce in the 35,000 dwt class. These vessels with dimensions of about 690' x 93' x 36.' draft will require anchorage to wait for tide in the 35-foot Fore River. Should the vessels be denied anchorage inside the harbor, Hussey Sound will have to be utilized. For these vessels, similar to the 35,000 dwt vessels

carrying crude, it is estimated that 50 percent of the trips will require anchorage and be delayed for the same time and average the same costs as the 35,000 ton tankers carrying crude oil. The costs, estimated previously for the 35,000 ton tankers, are $400 per trip. One-half the annual trips would be 73. Thus the savings to be realized would be 73 x 400 or $29,200. Of the 73 anchorages required, about 10 trips would incur fog delays averaging 24 hours each. Thus a total of 240 hours would be saved, by provision of House Island anchorage giving a total benefit of $300 x 240 or $72,000. This $72,000 combined with the $29,200 would give a total benefit of $101,200. The higher hourly operating costs for these vessels are attributable to U. S. shipping. Since these benefits will be realized about the end of the anticipated project life, the equivalent value of the savings is taken as an average annual benefit. The benefit would thus be $101,200x0.40405 or $41,100 attributable to the House Island anchorage.

Summary of Benefits

	45'-Channel and Maneuvering Basin	45' Anchorage	Total
Transportation Savings (60,000 dwt vessels)	$1,464,000		$1,464,000
Elimination of Anchorage Delays (60,000 dwt vessels)		79,700	79,700
Elimination of Tidal Delays (45,000 dwt vessels)	49,800		49,800
Elimination of Anchorage Delays (45,000 dwt vessels)		99,800	99,800
Elimination of Anchorage Delays (35,000 dwt)Crude Oil Commerce		80,200	80,200
Elimination of Tidal Delays (35,000 dwt) Crude Oil Commerce	16,100		16,100
Elimination of Anchorage Delays Anticipated Fore River Traffic		41,100	41,100
Total	$1,529,900	$302,800	$1,830,700

APPENDIX C

ESTIMATE OF FIRST COST

1. The first cost of the improvement recommended in this report is given below. Federal construction consists of dredging to provide a 1000-foot wide channel and a 234-acre anchorage, both to a depth of 45 feet. The U. S. Coast Guard estimates that one additional buoy will be required and three existing buoys relocated.

2. Probings made during the studies indicate that dredging will consist of mud, gravel and rock which will require removal by drilling and blasting the rock and dredging by bucket dredge with disposal at sea. Dredging quantities are in terms of in-place measurement, and include allowances of two feet of overdepth, side slopes of 1 on 1 in rock and one vertical on three horizontal in ordinary materials. Cost estimates are based on prices prevailing in September 1960.

PROJECT COST ESTIMATE

Cost Account Number		Cost Estimate (x $1000) (Sept 1960)
.09	CHANNELS	
	45' Channel and Maneuvering Basin	
	1,523,000 cubic yards of mud, clay and gravel @ $1.50	$2,285.0
	21,000 cubic yards of ledge rock (granite) @ $39.00	819.0
		$3,104.0
	45' Anchorage	
	2,504,000 cubic yards of mud, clay and gravel @ $1.50	3,757.0
		$6,861.0
	Contingencies @ 15%	1,029.0
	Aids to Navigation (U. S. Coast Guard)	28.0
		$7,918.0
29	PREAUTHORIZATION STUDIES	35.0
30	ENGINEERING AND DESIGN	50.0
31	SUPERVISION AND ADMINISTRATION	400.0
		$8,403.0

R 10/14/60

PORTLAND HARBOR, MAINE

INFORMATION CALLED FOR BY SENATE RESOLUTION 148,
85th CONGRESS, ADOPTED 28 JANUARY 1958

1. NAVIGATION PROBLEMS. Portland Harbor, Maine is located on the southerly coast of Maine. It is about 100 miles northeast of Boston, Massachusetts. The harbor is commercial, ranking second in New England in the volume of its commerce, which exceeds 16,000,000 tons a year, has an entrance channel with a controlling depth of 38 feet, inside anchorages of 35-foot and 30-foot depths, and a 35-foot channel in the inner harbor. Ninety-five percent of the commerce is in crude petroleum and petroleum products.

2. The chief difficulties in navigation result from high spots in the entrance channel restricting its use to 45,000 dead weight ton tankers or less, which can come into the harbor only at high tide. Ships larger than the 45,000 dead weight ton maximum are denied entrance to the harbor. Another difficulty results from lack of sheltered anchorage in the inner harbor for the larger vessels. The larger vessels are now forced to anchor in Hussey Sound, involving extra costs and weather delays.

3. IMPROVEMENTS CONSIDERED. Local interests requested overall improvement of the harbor. The specific requests are listed below:

a. Removal of three high spots in the entrance channel to provide for a channel to provide for a channel 45 feet deep.

b. Deepen the existing 35-foot anchorage to 45 feet.

c. Provision of a 45-foot alternate entrance channel through Hussey Sound.

d. Deepen and enlarge the existing 30-foot deep anchorage to 35 feet.

e. Deepen two high spots at the edge of the entrance channel to 45 feet.

f. Deepen Fore River to 37, 38, or 40 feet.

The need for an alternate 45-foot channel was not found sufficiently warranted to justify its high cost. Similarly deepening the existing 30-foot anchorage and Fore River was not found to be economically justifiable at this time. It was found also that a 1000-foot wide entrance channel could be obtained without removal of the two shoals at the edge of the channel. Therefore no further consideration was given to removal of these shoals.

4. RECOMMENDED IMPROVEMENT. To provide adequate depth in the entrance channel for the large super-tankers now using the harbor and for the larger super-tankers expected to use the harbor, a channel 45 feet deep and 1000 feet wide, is recommended. In addition a sheltered anchorage, 45 feet deep, generally within the limits of the 35-foot existing anchorage, is recommended. Estimated first costs, annual costs and annual benefits are based on September 1960 price levels; a

50-year project life, and a 2-5/8 percent interest rate on Federal Funds. The estimated costs are as follows:

a. Estimated first cost of construction

Federal	$8,403,000.
Non-Federal	--
Total Estimated First Cost of Construction	$8,403,000.

b. Estimated Annual Charges

	Federal	Non-Federal	Total
Interest and Amortization	$ 303,700	-	$303,700
Maintenance	4,100	-	4,100
Total Estimated Annual Charges	307,800	-	307,800

c. Estimated Annual Benefit. Benefits result from savings in transportation for the larger ships, elimination of tidal delays, elimination of weather delays in provision of anchorage and elimination of extra costs, involved in present anchorage.

General	Local	Total
$1,830,900.	-	$1,830,900.

d. Benefit Cost Ratio = 6.0

5. APPORTIONMENT OF COST AND LOCAL COOPERATION. In view of the nature of the benefits, which are general in nature, no local cash contribution should be required. As a requirement of local cooperation, local interests should

a. Provide without cost to the United States, all necessary lands, easements, and rights-of-way for the construction and subsequent maintenance of the project.

b. Hold and save the United States free from damages that may result from construction and subsequent maintenance of the project.

c. If it is determined in detailed studies that spoil-disposal areas are needed, local interests agree to furnish, upon the request of the Chief of Engineers, and without cost to the United States, any such areas required, including such dikes, bulkheads and embankments as may be necessary, for the initial dredging and subsequent maintenance.

6. DISCUSSION. Local interests have been advised of the recommended improvement and have indicated that the requirements of local cooperation would be met. The recommended improvements provide a satisfactory and economically feasible means of meeting the needs of navigation for the present and prospective petroleum commerce. Analysis on the basis of a 100-year life would increase the benefit-cost ratio from 6.0 to 7.5. The project is considered justified on the basis of studies and criteria in the report. Proposed local cooperation is consistent with that required in similar projects.

CORPS OF ENGINEERS — U. S. ARMY

N 12,000 — N 11,000 — N 10,000 — N 9,000 — N 8,000 — N 7,000 — N 6,000

E 5,000 — E 4,000 — E 3,000 — E 2,000 — E 1,000

N

DESIRED IMPROVEMENT RECOMMENDED
CHANNEL 1,000 FEET WIDE, 45 FEET DEEP

Flood
Ebb

HOUSE ISLAND

SCAMMEL X (1938)

EAST CHANNEL LIMIT

WEST CHANNEL LIMIT

1000

MATCH LINE SHEET NO. 2

35.0'

45.0'

P-1 P-2 P-3 P-4 P-5 P-6 P-7 P-8 P-9 P-10 P-11 P-12 P-13 P-14 P-15 P-16 P-17 P-18 P-19 P-20 P-21 P-22 P-23 P-24 P-25 P-26 P-27

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	ELEVATION BELOW M.L.W. DEPTH OF PROBE	PENETRATION	MATERIAL
1	43.3	50.6	7.3	Mud - wt. of pipe
2	41.7	45.1	3.4	Mud - rock
3	43.9	51.7	7.8	Mud - wt. of pipe
4	41.8	50.8	9.0	Mud - hard pack
5	39.2	49.8	10.6	Top crust - mud
6	44.0	49.6	5.6	Mud - wt. of pipe
7	44.8	50.1	5.3	Mud - refusal
8	41.0	48.3	7.3	Mud - rock
9	41.4	48.3	6.9	Mud - rock
10	45.0	51.2	6.2	Mud
11	42.4	51.3	8.9	Mud
12	44.5	51.4	6.9	Mud - clay
13	44.3	48.3	4.0	Mud & gravel
14	43.4	48.6	5.2	Mud & gravel
15	39.7	47.9	8.2	Mud & gravel
16	43.2	49.0	5.8	Mud & gravel
17	43.1	51.1	8.0	Mud & gravel
18	44.1	51.0	6.9	Mud & gravel
19	43.6	51.2	7.6	Mud & gravel
20	43.9	47.9	4.0	12 blows to ft. in h. p.
21	45.5	46.3	0.8	Rock
22	42.5	42.9	0.4	Rock

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	ELEVATION BELOW M.L.W. DEPTH OF PROBE	PENETRATION	MATERIAL
23	36.0	37.3	1.3	Mud - rock
24	38.5	40.3	1.8	Rock
25	45.5	47.3	1.8	15 blows-grade in mud
26	39.4	39.4	0.0	Rock
27	47.2			Mud
28	36.7	38.0	1.3	Mud - rock

NOTES:

Soundings and probes are from surveys of 1959 by J. Rock.

Soundings are in feet and tenths and refer to the plane of M. L. W..

Grid based on local plane coordinates with origin at Ft. Preble, So. Portland.

LEGEND

Considered improvement

35 — foot contour shown thus:

45 — foot contour shown thus:

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.

PORTLAND HARBOR
MAINE
SURVEY MAP

IN 7 SHEETS — SCALE IN FEET (200 0 200 400 600) — SHEET NO. 1

APPROVED: for Wm. Leslie
CHIEF, ENGINEERING DIVISION

SUBMITTED:
CHIEF, PLANNING AND REPORTS BRANCH

CHIEF, RIVER AND HARBOR SECT.

PROJECT ENGINEER

TO ACCOMPANY SURVEY REPORT DATED: SEPT. 15, 1960

FILE NO. 1451-D-1-4

CORPS OF ENGINEERS

U. S. ARMY

DESIRED IMPROVEMENT RECOMMENDED

ANCHORAGE & MANEUVERING AREA
45 FEET DEEP

W 1,000 | L 47,000 | E 1,000 | E 2,000 | E 4,000 | E 5,000

N 15,000 | N 14,000 | N 13,000 | N 12,000

DIAMOND IS.

FT. GORGES

LITTLE DIAMOND ISLAND

HOUSE ISLAND

ANCHORAGE

HOUSE ISLAND

N

Flood
Ebb

MATCH LINE SHEET NO. 3

MATCH LINE SHEET NO. 1

UPSTREAM LIMIT OF RECOMMENDED 45-FT. CHANNEL

PORTLAND PIPELINE CORP. PIER-2

42-FOOT BERTH

SPRING PT. LT.

BREAKWATER (EXISTING PROJECT)

LEDGE 3 (EXISTING PROJECT)

LEDGE 3A (EXISTING PROJECT)

See Sheet No. 1 for probing record

BG-3

P-1 P-29 P-30 P-31 P-32 P-33 P-34 P-35 P-36 P-37 P-38 P-39 P-40 P-41 P-42 P-43 P-44 P-45 P-46 P-47 P-48 P-49 P-50 P-51 P-52 P-53 P-54 P-55 P-56

LIST OF PROBINGS

NUMBER	ELEVATION BELOW M.L.W. DEPTH OF WATER	DEPTH OF PROBE	PENETRATION	MATERIAL
29	38.7	47.1	8.4	Mud
30	36.9	49.0	12.1	Mud
31	38.7	48.8	10.1	Soft mud
32	35.0	46.8	11.8	Mud
33	38.6	49.4	10.8	Soft mud
34	38.0	47.2	9.2	Clay to mud
35	38.2	45.1	6.9	Soft mud
36	37.2	46.2	9.0	Mud
37	37.5	45.9	8.4	Mud
38	38.1	46.5	8.4	Mud
39	37.9	45.0	7.1	Soft mud to hard clay
40	36.4	49.1	12.7	Mud
41	36.9	48.9	12.0	Mud
42	35.6	48.7	13.1	Mud
43	35.6	48.2	12.6	Mud
44	36.9	45.5	8.6	Mud
45	35.7	48.3	12.6	Mud
46	38.0	47.1	9.1	Mud
47	37.3	46.7	9.4	Mud
48	40.0	48.2	8.2	Mud
49	39.3	50.5	11.2	Mud
50	37.6	52.2	14.6	Mud
51	37.0	45.1	8.1	Mud
52	40.6	46.1	5.5	Mud
53	44.0	47.3	3.3	Hard packed mud
54	41.4	45.0	3.6	Hard clay
55	41.1	47.3	6.2	Mud
56	41.9	47.5	5.8	Mud

NOTES:

Soundings are from surveys of 1957 by H. A. Fishlock and 1960 by J. Rock.

Probings are from survey of 1959 by J. Rock.

Soundings are in feet and tenths and refer to the plane of M. L. W.

Grid based on local plane coordinates with origin at Ft. Preble, South Portland.

LEGEND:

Considered improvement: ——

35—foot contour shown thus: ------

45—foot contour shown thus: — —

Existing project shown thus: ——

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.

PORTLAND HARBOR
MAINE
SURVEY MAP

IN 7 SHEETS | SHEET 2

SCALE IN FEET 200 0 200 400 600

APPROVED: [signature] Chief, Engineering Division

SUBMITTED: [signature] Chief, Planning and Reports Branch

[signature] Chief, River and Harbor Sect. DR. BY [signature] CH. BY [signature]

[signature] Project Engineer

TO ACCOMPANY SURVEY REPORT DATED SEPT. 15, 1960

FILE NO. 1451 D-1-4

CORPS OF ENGINEERS

U. S. ARMY

DESIRED IMPROVEMENT
NOT RECOMMENDED
ENLARGE AND DEEPEN EXISTING
30-FOOT ANCHORAGE TO 35 FEET

MATCH LINE SHEET NO. 4

MATCH LINE SHEET NO. 2

W 5,000 | W 4,000 | W 3,000 | W 1,000 | LAT. 000

N 17,000 | N 16,000 | N 15,000 | N 14,000 | N 13,000 | E 1,000

FISH POINT

PORTLAND

SOUTH PORTLAND

FORE RIVER

Flood
Ebb

EXISTING 30-FOOT ANCHORAGE

35-FOOT CHANNEL

EXISTING

DIAMOND LEDGE BN.

WHARVES

TRUNK

GRAND

MAINE STATE PIER

WHF. 1

WHF. 2

WHF. 3

GRAIN (1959)

KARM

BIT

BUG

BUG LT.

SHIP

N

NOTES:

Soundings are from surveys of 1959 by J. Rock.

Soundings are in feet and tenths and refer to the plane of M.L.W..

Grid based on local plane coordinates with origin at Ft. Preble, South Portland.

LEGEND

Considered Improvement ——— ———

35—foot contour shown thus: – – – – –

Existing project shown thus: ———

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.

PORTLAND HARBOR
MAINE
SURVEY MAP

IN 7 SHEETS — SHEET 3

SCALE IN FEET
200 0 200 400 600

APPROVED:
CHIEF, ENGINEERING DIVISION

SUBMITTED:
CHIEF, PLANNING AND REPORTS BRANCH

CHIEF, RIVERS AND HARBOR SECT.

PROJECT ENGINEER

DRAWN BY
TRACED BY
CHECKED BY

TO ACCOMPANY SURVEY REPORT DATED SEPT. 15, 1960

FILE NO. 1451 D-1-4

CORPS OF ENGINEERS

U. S. ARMY

W 2,000 | W 1,000 | LAT 000 | E 1,000 | E 2,000 | E 3,000 | E 4,000 | E 5,000

N 22,000 | N 21,000 | N 20,000 | N 19,000 | N 18,000

HALFWAY ROCK

DESIRED IMPROVEMENT
NOT RECOMMENDED
ENLARGE AND DEEPEN EXISTING 30-FOOT ANCHORAGE TO 35 FEET
DEEPEN TO 35 FEET

30-FOOT APPROACH CHANNEL

EXISTING 30-FOOT ANCHORAGE

POMROY ROCK

C-7 | C-5 | N-4 | N-2

Flood
Ebb

N

MATCH LINE SHEET NO. 3

NOTES:

Soundings from survey of 1959 by J. Rock, supplemented by available soundings from U.S.C. & G.S..

Soundings are in feet and tenths and refer to the plane of M. L. W.

Grid is based on local plane coordinates with the origin at Ft. Preble, So. Portland.

LEGEND:

Considered Improvement

30-foot contour shown thus

Existing project shown thus:

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.

PORTLAND HARBOR
MAINE
SURVEY MAP

IN 7 SHEETS | SHEET 4

SCALE IN FEET 200 0 200 400 600

APPROVED:
CHIEF, ENGINEERING DIVISION

SUBMITTED:
CHIEF, RIVERS AND HARBORS BRANCH

CHIEF, RIVER AND HARBOR SECTION

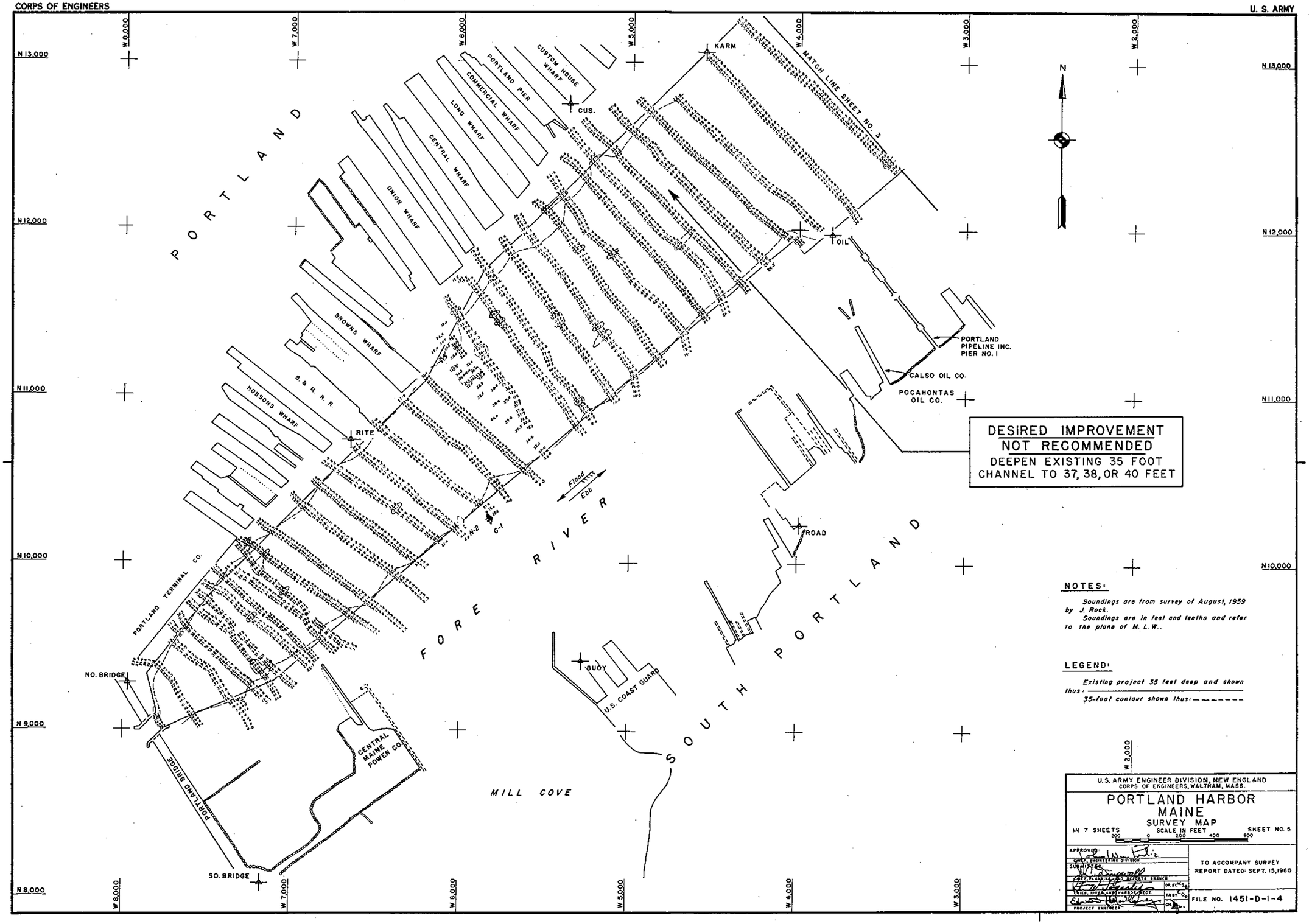
PROJECT ENGINEER

TO ACCOMPANY SURVEY REPORT DATED SEPT. 15, 1960

FILE NO. 1451 D-1-4

CORPS OF ENGINEERS

U. S. ARMY



DESIRED IMPROVEMENT NOT RECOMMENDED

DEEPEN EXISTING 35 FOOT CHANNEL TO 37, 38, OR 40 FEET

NOTES:

Soundings are from survey of August, 1959 by J. Rock.

Soundings are in feet and tenths and refer to the plane of M. L. W.

LEGEND:

Existing project 35 feet deep and shown thus: ———

35-foot contour shown thus: – – – – – –

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.

PORTLAND HARBOR
MAINE
SURVEY MAP

IN 7 SHEETS — SCALE IN FEET (200 0 200 400 600) — SHEET NO. 5

APPROVED

CHIEF, ENGINEERING DIVISION

SURVEYED

CHIEF, PLANNING AND REPORTS BRANCH

DR. BY: MCS

CHIEF, NEW ENGLAND HARBOR SECT. TAB BY: FO

PROJECT ENGINEER CH

TO ACCOMPANY SURVEY REPORT DATED: SEPT. 15, 1960

FILE NO. 1451-D-1-4

CORPS OF ENGINEERS — U. S. ARMY

W 14,000 — W 13,000 — W 12,000 — W 11,000 — W 10,000 — W 9000 — W 8000

N 10,000 — N 9000 — N 8000 — N 7000 — N 6000

N

PORTLAND

SOUTH PORTLAND

FORE RIVER

DESIRED IMPROVEMENT
NOT RECOMMENDED
DEEPEN EXISTING 35 FOOT
CHANNEL TO 37, 38, OR 40 FEET

EXISTING 35' CHANNEL

Flood

Ebb

PORTLAND TERMINAL CO.

G08

C-3

C-1

N. BRIDGE

PORTLAND BRIDGE

ROUND

GULF OIL CORP.

FORMER VAUGHAN BRIDGE

ROLLING MILL

L-WHARF

(TIDEWATER RICHFIELD SHELL GULF OIL)

PROJECT LIMIT

T- WHARF

CITIES SERVICE

SOCONY MOBIL

AMERICAN OIL CO.

TOMB

MEXPET

FOUR

TEXAS CO.

NOTES:
Survey of June 23 1960 by H.A. Fishlock.
Portland bridge B.M. "1 a standard U.S. E. disk set in concrete base of the most southerly six column concrete pier. It is seven inches in from the north face and between the first & second easterly column. Elev. is 20.37 above M.L.W.
Field books: R.& H. 1611, 1774 & 1775
35-Foot contour shown thus: - - - - - -
Existing project shown thus: ———

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.

PORTLAND HARBOR
MAINE
SURVEY MAP

IN 7 SHEETS — SHEET NO. 6

SCALE IN FEET
200 0 200 400 600

APPROVED:
CHIEF, ENGINEERING DIVISION
SUBMITTED:
CHIEF, PLANNING AND REPORTS BRANCH
CHIEF, ENGR. DIV. (FOR DIV. ENGR.)
PROJECT ENGINEER

DR. BY
TR. BY
CHKD.

TO ACCOMPANY SURVEY
REPORT DATED: SEPT. 15, 1960

FILE NO. 1451-D-1-4

CORPS OF ENGINEERS

U. S. ARMY

GREAT DIAMOND ISLAND

LITTLE DIAMOND ISLAND

PEAKS ISLAND

HUSSEY SOUND

EVERGREEN LANDING

TREFETHEN

CITY POINT

DESIRED IMPROVEMENT
NOT RECOMMENDED
ALTERNATE ENTRANCE CHANNEL
600 FEET WIDE 45 FEET DEEP

600'

CABLE AREA

LIMIT HOUSE ISLAND ANCHORAGE

MATCH LINE SHEET NO. 2

DOLPHIN

PILING

PILES

PILES

SEWER

Flood
Ebb

E.5,000 E.6,000 E.7,000 E.8,000 E.9,000 E.10,000 E.11,000

N19,000 N18,000 N17,000 N16,000 N15,000

NOTES:

Soundings are from U.S.C. & G.S.
Soundings are in feet and tenths and refer to the plane of M.L.W..
Grid based on local plane coordinates with origin at Ft. Preble, So. Portland.

LEGEND:

45- contour shown thus
Considered improvement
Existing project

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.

PORTLAND HARBOR
MAINE
SURVEY MAP

IN 7 SHEETS

SHEET NO. 7

SCALE IN FEET
200 0 200 400 600

APPROVED
CHIEF, ENGINEERING DIVISION

SUBMITTED
CHIEF, LIGHT HOUSES BRANCH
CHIEF, RIVERS AND HARBOR SECT.
PROJECT ENGINEER

DR. BY
TR. BY
CH. BY

TO ACCOMPANY SURVEY
REPORT DATED SEPT. 15, 1960

FILE NO. 1451-D-1-4